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THE OSTEOGENIC POWER OF PERIOSTEUM: WITH A NOTE ON BONE TRANSPLANTATION. AN EXPERIMENTAL STUDY.

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AND

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INTRODUCTION.

The appearance of Macewen's monograph [1] caused considerable discussion among those interested in the growth of bone. His experiments seemed to show that periosteum was not a bone-producing tissue, but that its function was simply that of a limiting membrane. This, of course, was not in accordance with the principles accepted for many years, and it was difficult to adjust ourselves to his ideas without first-hand experimental proof.

The literature on this subject has been fully commented on in a number of recent experimental and clinical papers, so we shall not consider it at this time. Suffice it to say that some investigators found osteogenic power in periosteum and others did not.[2]

We approached the subject with, as far as possible, unbiased minds, although, if we had a leaning more one way than another, it was to the opinion that periosteum was a bone-producing tissue. In order to clear the matter up for our own satisfaction, we have repeated during the last two years many of Macewen's experiments, and also have carried out a number of our own.

One hundred and sixty-seven experiments were done on 50 dogs and 17 rabbits. The ordinary run of laboratory animals were used, although as far as possible young animals were selected. Ether anesthesia was used in each experiment.

Technic.—The part was shaved or the hair was removed with a solution of sodium sulphide. The skin was washed with

[1] "The Growth of Bone." William Macewen, F. R. S. (1912).

[2] In many of the original reports there is paucity of detail as to whether macroscopic particles of bone were adherent to and transplanted with the periosteum. We feel that definite conclusions as to the bone producing power of periosteum can only be drawn from those experiments in which every effort was made to remove the periosteum without particles of the underlying bone. The character of the wound healing is also very lightly touched upon in many of these papers. It is also well to bear in mind that Ollier's classic work on bone and periosteum was done in the pre-antiseptic period of surgery.

green soap and water, then with alcohol, followed by ether. After the skin was thoroughly dry it was painted with tincture of iodin, 2.5 per cent. The iodin solution was also occasionally used in the open wounds and after suture of the skin. Fine black silk was the ligature and suture material used throughout. The wounds were closed in layers wherever possible. Collodion and gauze dressings were applied when necessary. Unless otherwise stated the healing will be understood as *per primam*. Land-mark sutures were used when periosteum or bone was placed in the soft parts. *The results were controlled by careful dissection and by X-ray and microscopic examinations.*[a]

In these experiments, except where definitely specified to the contrary, care was taken not to remove any particles of bone with the periosteum. This was accomplished by outlining the periosteal flap down to the bone with a scalpel, and starting it away from the bone with a blunt instrument. Then by means of a small, very firm gauze pad, grasped in an artery clamp, the periosteum was removed without disturbance of the surface of the bone.

Microscopic examination shows that the periosteum with the greater part of the underlying osteoblasts may be removed in this way.

For convenience in comparing the results we have divided the experiments into groups.

Group I.

The transplantation of free flaps of periosteum.

A. The Transplantation of Free Periosteum Without Bone Particles Into the Muscle or Subcutaneous Tissue of the Same Animal.

Typical Experiment.—Mongrel dog; about 6 months old. *Operation:* The right femur was exposed and the periosteum was removed from 5 cm. of its circumference. The periosteum was then placed in the body of an adjacent muscle, and stretched between two sutures. The wound was closed. After 30 days the site of the transplant was occupied by a thin band of fibrous tissue, in which no bone could be made out. There was no thickening of the area from which the periosteum had been removed. The nourishment of the bone was unimpaired.

Summary.—We made 21 experiments; 16 on dogs and 5 on young rabbits. The flaps of periosteum varied in size from that of the entire femur to an area 1 cm. wide from the circumference of the radius. In one experiment the periosteum from a section of fibula 1.6 cm. long was turned inside out in stripping it from the bone, thus exposing the surface next to the bone. In six experiments the periosteum was placed in the subcutaneous tissue, and in 15 in the muscle tissue. The periosteum was spread out and sutured in position in 7 experiments, and in 14 it was bunched. The specimens were examined 8, 14, 15, 19, 30, 31, 35, 78, 94, 95, 104, 113 and 133 days after operation, and in no instance could any growth of bone be detected.

B. The Transplantation of Free Periosteum Without Bone Particles Into the Muscle or Subcutaneous Tissue of Another Animal of the Same Species.

Typical Experiment.—Fox terrier; about 4 months old. *Operation:* The periosteum obtained from a section of the radius, 3 cm. long, was bunched and placed in the subcutaneous tissue. The wound was closed. After 123 days no new bone formation was found. The site of the transplant was easily recognized by means of the land-mark sutures, but the transplant itself had entirely disappeared.

Summary.—Five experiments were done on dogs. The periosteum was obtained from the circumference of a resected portion of the radius, varying in length between 2.2 and 3 cm. The transplants were placed in the subcutaneous tissue in 3 experiments and in the muscle in 2. In each experiment the periosteum was bunched. The specimens were examined 27, 91, 121, 123 and 126 days after operation, and in no instance was any growth of bone detected.

C. The Injection Into the Soft Parts of Small Bits of Periosteum, Without Bone Particles, in Suspension.

Typical Experiment.—Young rabbit. *Operation:* The tibia was exposed and a flap of periosteum 2.7 x .5 cm. was removed and cut into very small pieces. This was shaken up in 15 minims of Ringer's solution. This mixture was injected by means of a syringe through a stab wound, into the subcutaneous tissue of the thigh, at some distance from the opening. The wound was closed. After 29 days no new bone could be demonstrated, and no sign of the periosteum could be found.

Summary.—Six experiments were done on rabbits. The periosteum was obtained from the tibia in each instance. The flaps varied between 2 and 3 cm. in length by .5 cm. in width. The periosteum was cut into small bits with scissors, and was shaken up with from 10 to 15 minims of normal salt solution in 3 experiments, in Ringer's solution in 2 experiments, and in blood in 1 experiment. The injections were made into the subcutaneous tissue and muscle, three times each. The specimens were examined 10, 13, 29, and 32 days after injection. In 1 experiment, 32 days after the injection of periosteum in salt solution, a single oblong bit of calcified tissue, 4 x 2.5 mm., was found. There is doubt, however, as to the origin of the fragment, as the injection was made subcutaneously into the lateral aspect of the middle of the thigh, while the calcified tissue was found close to the joint beneath the rectus muscle. Microscopic examination showed deeply staining calcified material with no bone. In the other experiments no bone formation could be demonstrated.

These three groups of experiments show that neither free auto- nor iso-periosteum has the power of bone production when transplanted into soft parts, even though a considerable number of osteoblasts be adherent to the transplant.

D. The Transplantation of Free Periosteum With Thin Bone Shavings Attached, Into Soft Parts of the Same Animal.

[a] We take this opportunity of expressing our thanks to Dr. Harry F. Baetjer for the X-ray plates; and to Mr. C. R. Thomas for his aid in the operative experiments.

TYPICAL EXPERIMENT.—Mongrel dog; about 1 year old. *Operation:* A flap of periosteum, 3 cm. in length by one-half the circumference of the femur in width, was removed, with thin shavings of bone attached to it, and was placed in a pocket burrowed in muscle tissue. After 128 days a small area of bone was found, which cast a shadow on the X-ray plate. Microscopically new bone was demonstrated.

SUMMARY.—Seven experiments were done on dogs. The periosteal flap with shavings of bone attached was obtained from the femur in each instance. It was either raised with a very thin chisel, or roughly with a curette. The flaps varied between 3 and 3.5 cm. in length by 1 cm. to one-half the circumference of the femur in width. Such a flap was placed in the subcutaneous tissue six times and in muscle tissue once. The specimens were examined 11, 64, 67, 127 and 128 days after operation. In each experiment there was definite bone formation. This bone growth was very much smaller than might have been expected from the size of the transplant with attached shavings. In no experiment was the new bone more than 4 mm. long by 1 mm. thick. In no instance was there more than a very slight roughening of the surface of the femur, from which the periosteum and bone shavings had been removed.

This group of experiments shows definitely that free periosteal flaps with bone shavings attached produce new bone. When compared with the results of transplantation of free periosteum without bone particles it shows that bone particles and accompanying osteoblasts are necessary for the production of bone. It may be that this new bone would eventually have been absorbed, as the specimens contained a great deal less bone than was originally transplanted, in spite of the fact that so large a surface was exposed for the reception of a new blood supply.

E. The Transplantation of Free Periosteum Without Bone Particles, Congealed in a Blood Clot, Into the Subcutaneous Tissues of the Same Animal.

TYPICAL EXPERIMENT.—Fox terrier; about 8 months old. *Operation:* A flap of periosteum, 3.5 x .75 cm., was removed from the shaft of the femur. It was bunched and congealed in a blood clot, which was then placed in a pocket burrowed in the subcutaneous tissue of the thigh. The pocket was closed with a purse-string suture. After 20 days, at the site of the transplant there was a small amount of clear fluid, but no sign of the periosteum.

SUMMARY.—Eight experiments were done on dogs. The periosteum was obtained from the shaft of the femur. The flaps varied between 2 and 4 cm. in length, by .75 cm. to one-half the circumference of the femur in width. In each experiment the periosteum was bunched and congealed in a blood clot, which was placed in the subcutaneous tissue. The specimens were examined 20, 87, 100, 112 and 113 days after operation. In 4 experiments, after 20, 87, 100 and 113 days, a well-marked scar was found, but no evidence of bone formation. In 4 others (100 and 112 days) a tiny calcified mass, scarcely 1 mm. in diameter, was found at the site of the transplant. In the 100 days' specimen there had been a slight superficial infection of the skin wound, and although this was at some distance from the transplant, it may have had an influence on the deposit of lime salts. Microscopic examination showed definite new bone formation in both specimens, but it was much more marked in the one than in the other. In the 112 days' experiments, on the other hand, the healing had been *per primam*, and the calcified material was smaller than in the 100 days' experiment. Microscopic examination showed calcified material, but no definite bone tissue.

Calcification occurred in 4 of the 8 experiments. In 1 of these a small amount of bone was demonstrated microscopically. In another only a tiny particle of bone could be found, while in the 2 other experiments showing calcification no bone could be found. It is well known that calcification in blood clots occasionally occurs, and it is possible that the presence of periosteum without bone particles in the blood-clots may have influenced the deposit of lime salts. Taking into consideration the preceding experiments, it is probable that in the 2 experiments in which bone was definitely demonstrated some particles of bone had accidentally been transplanted with the periosteum.

GROUP II.

THE TRANSPLANTATION OF PEDUNCULATED FLAPS OF PERIOSTEUM.

A. The Transplantation of Pedunculated Flaps of Periosteum Without Bone Particles Into or Around Adjacent Muscles.

TYPICAL EXPERIMENT.—Mongrel dog; about 10 months old. *Operation:* The radius was exposed and an area of periosteum, 4 x 1.25 cm., was outlined on three sides. The flap was raised, care being taken not to disturb the bone. The base of the flap was situated at the lower epiphyseal line. The flap was then passed around adjacent muscle tissue, and the free end brought back and sutured to the cut edge of the radial periosteum. The wound was closed. After 151 days no new bone formation could be demonstrated. The periosteal flap had entirely disappeared. There was very slight thickening of the bone over the area from which the periosteum had been raised.

SUMMARY.—Four experiments were done on dogs. The radius was utilized in each instance. The flaps were from 1 to 1.5 cm. wide and from 3 to 4.5 cm. long. In 2 experiments the pedicle was left attached to the shaft of the bone, and in 2 to the epiphyseal line. In one of each the flap was drawn out into the adjacent muscle tissue, and in the others the free end was sutured to the cut edge of the radial periosteum. The specimens were examined 151, 212, 216 and 220 days after operation. In no instance could any bone formation be demonstrated. In 2 experiments, the surface from which the periosteum was raised was scarified, and in each of these there was slight roughening of the bone at the point of scarification. This also occurred in 1 experiment in which the bone was not scarified, while in the other the bone was perfectly

smooth. The roughening could be felt rather than seen. It was easy to demonstrate the area from which the flap had been raised, as the line of incision was outlined at the time of operation with sterile India ink, and enough remained to definitely show the location.

These experiments show that there is no bone formation from periosteum, even though the periosteal flap is still attached by a pedicle to the bone itself.

B. The Transplantation of Pedunculated Flaps of Periosteum, With a Thin Film of Bone Attached, Into Adjacent Soft Parts.

TYPICAL EXPERIMENT.—Mongrel dog; about 6 months old. *Operation:* The femur was exposed and an area of periosteum, 3 x .8 cm., was outlined on three sides and raised with a thin film of bone attached. The adjacent muscle tissue was sutured beneath it, so that the pedunculated periosteum-bone flap was held away from the shaft of the femur. The wound was closed. After 34 days the flap was found thickened throughout. It was firmly attached to the femur by much thickened bone. Cartilage could be seen in the thickened area, and cartilaginous bone was demonstrated by microscopic examination. The X-ray picture showed new growth of bone throughout the flap. The shaft of the femur was thickened at the base of the flap, but there was very little new bone growth over the area from which the flap had been raised.

SUMMARY.—Eight experiments were done on dogs; 4 on the ribs and 4 on the femur. The specimens were examined 23, 34, 50 and 171 days after operation. The flaps on the femur varied from 2 to 3 cm. in length, by .8 to 1 cm. in width; on the ribs from 1 to 3 cm. in length, by the width of the rib. On the femur the muscles were sutured beneath the flap, and on the ribs the adjacent soft parts. In 2 experiments the flap was accidentally detached from the rib, but its attachment was placed in contact with the denuded bone and secured. In each experiment the bone-periosteal flap lived and new bone formed from it. The intermediate cartilage stage was noted in the femur flaps, but not in the rib flaps.

These experiments show that pedunculated flaps of periosteum with a thin bone film will live and produce new bone and become greatly thickened. This thickening was considerably reduced in the 171 days' experiment, as might be expected. These experiments are of some clinical interest, as this is undoubtedly what happens when a strip of periosteum with bone, still attached to the bone at one end, is raised by trauma, and accidentally implanted in adjacent soft parts. The contrast, between what happens in this group and in the case of the pedunculated flaps of periosteum in soft parts without bone particles attached, is very significant and further strengthens the conclusion that the presence of bone on periosteum is necessary for the production of bone, (Fig. 1).

REMARKS.—From the results obtained in Groups I and II, we find that free periosteum, without bone particles adherent to it, will not produce new bone when transplanted into muscle or subcutaneous tissue of the same animal; that this is also true for iso-transplants of periosteum alone; that new bone was found in 2 experiments and calcification in 2, in which the free periosteum had been congealed in a blood-clot before transplantation (in the two experiments in which bone was found, it is possible that small bits of bone were accidentally transplanted with the periosteum); that free periosteal flaps with thin bone shavings attached did produce bone in each experiment; that pedunculated flaps of periosteum without bone did not produce bone in a single instance; that pedunculated flaps of periosteum with a thin film of bone did produce bone in every instance.

The clinical use of the free transplantation of periosteum is of value only in those instances in which periosteum has been employed to fill in defects. In such operations the result depends entirely on the formation of bone, and bone will not be formed unless bone is transplanted with the periosteum. The chances are that even the new-formed bone will eventually be absorbed. The pedunculated periosteal flap, with a thin film of bone attached, is of considerable interest, as it may help to explain some of the remarkable post-traumatic X-ray plates which are sometimes difficult to understand.

The nourishment of the bones was in no way affected by stripping off the periosteum, unless the nutrient artery was interfered with. In those instances in which the artery was cut, the bone was apparently normal, but the X-ray showed changes in its nutrition. In very few instances was the bone from which the periosteum was stripped visibly thickened, unless it had been considerably traumatized. In some instances in spite of chiseling and scraping there was practically no overgrowth of new bone.

The defects in the periosteum were, in many instances, replaced by a fibrous membrane, which resembled the periosteum in appearance, but was much more tightly adherent to the bone than was the normal periosteum. In some instances the muscle tissue was tightly adherent to the bone.

GROUP III.

THE SUBPERIOSTEAL RESECTION OF BONE, THE PERIOSTEAL TUBE, AS FAR AS POSSIBLE, BEING LEFT UNDISTURBED.

TYPICAL EXPERIMENT.—Mongrel dog; about 8 months old. *Operation:* A section of rib 3 cm. long was removed subperiosteally and the periosteal tube was closed. There was no blood-clot between the rib stumps. After 100 days the continuity of the rib was found restored, and except for a very slight thickening of the rib ends and the line of sutures in the periosteum, it would have been difficult to locate the site of operation.

SUMMARY.—Eleven experiments were done on dogs under 8 months old. In 8 experiments sections of rib were removed and, in 3, sections of the radius. The length of the pieces of rib removed varied between 1.5 and 3 cm. The length of the sections of radius varied between that of the entire radius with articulating surfaces and 2.5 cm. of the shaft. Metal caps were placed on the bone stumps under the periosteum in 3 experiments. The specimens were examined 14, 28, 31, 87, 100, 105, 106, 129, 141, 143 and 146 days after operation (Fig. 2).

In 4 of the experiments the periosteal tube was closed separately. In 7 the periosteal tube was drawn together by closure of the overlying soft parts.

In 2 experiments in which the periosteum was closed, the continuity of the rib was found completely restored, after 100 and 143 days, respectively. The size and appearance of the regenerated rib were nearly normal. The periosteal tubes were dry when closed.

In the 100 days' experiment it is difficult to say whether the new bone was formed from periosteum or from the rib ends, as the continuity of the newly formed bone was complete. In the 143 days' experiment, however, in the center of the defect there was a definite transverse line of contact of two fragments, which seems to show that the growth was from the rib ends along the tube with final junction. If this supposition is correct, the growth must have been from the rib ends along the periosteal tube, because, if it had been from the periosteum itself, there would have been no such line of junction. (It might be said that this line may have represented a subperiosteal fracture of the newly formed rib with healing, but if this were the case the continuity of the rib must have been complete before the fracture.)

In 4 of the experiments the periosteal tube was not closed separately after removal of the section of the rib. In 2 of these the defect was filled with bone. In 1 of these experiments (146 days) the continuity of the rib was completely restored. The new bone was flatter and thinner than the normal rib, but was in good line. In the other experiment (105 days) the defect was filled with bone, but there was motion in the center. The new bone was shown by the X-ray to be definitely from the rib stumps. The ends had grown long enough to touch each other and had then overlapped, instead of joining solidly. The new bone growth was not as thick as the normal rib, and was not quite in line with the intact rib. The growth was thicker and longer from the vertebral stump than from the sternal fragment. Had the growth been from the periosteum, it would probably have been fairly uniform in thickness, and the overlapping would have been unlikely.

In 2 of the other rib experiments, where the periosteal tube was not closed separately, the defect was not filled with bone. In 1 of these, after 14 days, no new bone formation could be made out. In the other, after 87 days, there was a definite growth of bone from both rib ends, but not enough to fill the defect. This growth was thicker from the vertebral than from the sternal stump. If the growth of bone had been from the periosteum it would have been of the same thickness throughout the defect. It is impossible to explain why the growth of bone in the 87 days' experiment was relatively slower than in the 100 and 105 days' experiments.

Two of the radial experiments will be considered together. In one, 5.8 cm. of the shaft of the radius were resected. No especial care was taken to remove the fine particles of bone left at the muscle attachments. After 31 days the X-ray plate showed a narrow line of bone formation between the stumps. This was apparently along the line of muscle attachment, where bone particles had probably been left. There was also bone formation from the radial stumps. Had the growth been from the periosteum alone, considering the size of the tube, it is probable that the growth would have been more extensive (Fig. 3).

In the other experiment the entire radius with its articular cartilages was removed. Especial care was taken to leave no particles of bone. After 129 days there was no bone formation demonstrable.

When we compare this experiment with the 31 days' experiment, it would seem to show that, unless bone particles are present in the periosteal tube after subperiosteal resection of bone, no bone is produced, except from the bone stumps.

In 3 experiments metal caps were placed over the stumps, inside the periosteal tube, in order to further test the bone-producing power of periosteum. Metal caps were placed on the rib stumps after subperiosteal resection of 1.5 cm. of a rib, and the periosteum was closed without blood-clot. After 28 days, no bone formation was present in the tube between the caps or around them.

In another experiment caps were placed on the stumps of the radius inside the periosteum, after subperiosteal resection of 2.5 cm. of the shaft. The tube was not sutured. There was no blood-clot. After 106 days the defect was found filled with a solid mass of bone, which impinged on the upper cap and spread out around it like an inverted mushroom. The lower fragment had been displaced laterally. The X-ray plate showed the growth of new bone to have formed from the side of the lower fragment, just below the cap, and to have followed the line of the tube. There was no growth of new bone around the upper cap.

In another experiment caps were placed on rib stumps after subperiosteal resection of 2 cm. of a rib. A blood-clot was placed in the tube and the periosteum was closed. After 141 days the continuity of the rib was found restored. The X-ray plate showed the caps in place. One of them was nearly surrounded by new bone and the defect was filled with new bone. Dissection showed the cap, which was not surrounded by bone, to be tilted outward, and the growth of new bone to have come from the side of the rib back of the cap. The new bone around the other cap seemed to have come from the rib behind the cap, but may have come partially from the periosteum. It is impossible to decide definitely (Fig. 4).

In the 106 days' experiment the new growth of bone was definitely from the side of the shaft of the lower fragment. In the 141 days' experiment the bone growth was, at one end, definitely from the rib behind the cap, while on the other end, in addition to growth from the rib behind the cap, it may probably have also had a periosteal origin. It is doubtful whether the blood-clot had anything to do with the bone formation. In the 28 days' experiment there was no attempt whatever at new bone formation between the caps and, if new bone was to be formed by the periosteal tube, it would probably have begun in four weeks.

The results with the metal caps confirm the idea that peri-

osteum alone without bone, even when its blood supply has been undisturbed, has not the function of producing new bone.

Remarks.—The group shows that the periosteum acts only as a limiting membrane. In those experiments without metal caps where the periosteal tube was closed separately, the size of the new-formed bone was almost normal. In those in which the periosteal tube was not closed, the bone was somewhat irregular in shape. In none of the experiments could it be definitely demonstrated that the new bone was produced from the periosteum. The only instance in which new bone occurred along the periosteal tube was in the case of a resection of a portion of the radius, in which experiment no particular attention was given to the removal of bone particles from the line of muscle attachment. Even in this experiment the growth of bone was much more marked at the radial stumps. In the metal cap experiments the growth of bone was definitely from the shaft of the bone behind the caps, rather than from the periosteum.

Group IV.

The transplantation of bone and other substances, into the periosteal tube after partial subperiosteal resection of a rib.

Typical Experiment.—Fox terrier; about 10 months old. *Operation:* An intact auto-phalangeal bone was transplanted between the rib stumps, after subperiosteal resection of a portion of a rib. The periosteal tube was closed over it. After 107 days the continuity of the rib was found restored, and there was thickening in the region of the transplant. The transplant was adherent to the rib and new bone beneath it at one end, but was slightly movable at the other end. The X-ray plate showed general atrophy of the transplant. It had been pushed to one side by the growth of new bone, which was apparently from the rib ends.

Summary.—Twenty-one experiments were done on dogs. The length of the sections of rib removed varied between 1.5 and 3 cm. The periosteum was closed over the transplant in 18 experiments, and the transplant was held in the periosteal trough by sutures in 3 experiments. Auto-bone with periosteum and without periosteum was used in two sets of 3 experiments. Iso-bone without periosteum was used in 10 cases. Auto-cartilaginous rib with perichondrium, cow's horn, dried iso-tendon, silver wire, and insoluble gelatin in 1 of each. The specimens were examined 24, 30, 31, 35, 44, 50, 92, 94, 100, 105, 107, 146, 206 and 215 days after operation.

Sections of auto-fibula, 2 cm. long, with periosteum, were placed between the rib stumps after the subperiosteal resection of two ribs. In one case the periosteal tube was closed over the transplant, and in the other the transplant was held in position by sutures. After 92 days the transplant over which the periosteum had been closed had grown firmly to the rib ends. There was slight thickening at its junction with the rib ends, but otherwise the size and shape of the bone was unchanged. The X-ray picture showed no attempt at bone growth from the periosteum outside the transplant. At the site of the other transplant, over which the periosteum had not been closed, there was considerable thickening of the bone with slight motion at one end. The X-ray plate showed the transplant in position, but partly surrounded by new bone. A recent fracture at the junction of the transplant with the rib allowed the motion. The bone around the transplant may have been partially derived from the periosteum, but had apparently originated from the rib itself, and followed the periosteal tube.

A section of auto-cartilaginous rib without bone was placed between the rib stumps after subperiosteal resection of a portion of a rib. After 39 days we found thickening at the junction of the transplant with the rib ends. The X-ray picture showed irregular ossification of the cartilage and bone growth into it from the rib ends. There was also a line of bone from one rib end, held in by periosteum, which extended over the surface of the perichondrium.

In each of those experiments, including the typical experiment, in which the transplants were covered with periosteum, the growth of bone, wherever present, had originated from the rib ends, and not from the periosteum. The periosteum and cartilage of the intact phalangeal transplant had prevented the entrance of any new bone from the rib ends, and the transplant had been pushed to one side by the bone growth from the rib ends, as an impervious foreign body would have been. The periosteal covering of the other transplants had allowed the growth of bone to enter the transplant only from the ends. In those instances in which there was growth over the surface it ran between the periosteal tube of the rib and the periosteal covering of the transplant.

In 2 experiments auto-bone shavings with blood were placed in the defect made by subperiosteal resection of a portion of a rib. The periosteum was not closed in either instance. In both of these specimens, after 50 and 94 days, respectively, the defect was filled with an irregular mass of dense bone, which was solidly adherent to one rib stump. The X-ray plate showed definitely that but little of the growth was from the stumps. The bone shavings may have lived or, being in contact with the periosteum, may have stimulated it to bone formation; or both conditions may have occurred.

To compare with these experiments we transplanted iso-bone shavings with blood into the defect after subperiosteal resection of a part of a rib, and closed the periosteum over the mass. After 100 days there was thickening at the site of the transplant and free motion in its center. The X-ray picture showed the defect filled with solid bone, except in the center, where there was a transverse cleft. This bone had followed the periosteal tube, and was apparently from the rib ends. If the growth of bone had been from the periosteum, the chances are that its growth would have been continuous.

A section of auto-skull-bone was shaped and placed in a defect made by subperiosteal resection of a portion of a rib. The periosteum was closed over the transplant. After 35 days there was marked thickening of the rib in the resected area. There was solid union of the transplant to the rib stump at one end, but movement at the other. The X-ray plate showed the graft acting as a foreign body, surrounded by new bone.

There was a growth of bone from each rib stump, but the principal growth seemed to be from the periosteum. Microscopic examination showed no bone growth from the transplant, but marked degeneration. This suggests that autobone without periosteum, when placed in a periosteal tube, may stimulate periosteum to new bone formation.

In 2 experiments sections of 3 ribs were resected subperiosteally, with intact ribs between, and into each defect was placed a section of iso-rib without periosteum. The periosteum was closed over each transplant. After 31 and 44 days the continuity of the ribs had been re-established in all. One is struck by the great amount of bone production, which may have been due to the constant movement of the chest wall. It also suggests that iso-bone without periosteum in a periosteal tube may have the power to stimulate bone growth from the periosteum, as well as from the rib ends. Four of these transplants were acting as foreign bodies and were being surrounded by bone, while two were being incorporated in the new growth. Each transplant represented a different stage in the process. The 44 days' specimen was slightly further advanced than the 31 days' specimen (Fig. 5).

A piece of split iso-humerus without periosteum, 2.2 cm. long, was shaped and placed in a defect made by subperiosteal resection of a portion of a rib. The specimen was examined 100 days later. A piece of iso-radius without periosteum, 2 cm. long, was similarly treated. The specimen was examined 105 days later. In both the periosteum was closed over the transplant. In both the continuity of the rib was re-established. In the 100 days' specimen the X-ray picture showed the transplant to be still intact and continuous with the rib ends. It was surrounded by new bone, which seemed to be from the rib ends, and possibly also from the periosteum. In the 105 days' specimen the transplant could not be found. The rib was thickened and the continuity was restored, but the transplant had disappeared. It is impossible to say whether the bone growth was from bone ends or from the periosteum, or both. The new bone followed the periosteal tube. It is difficult to believe that such different pictures could be produced under such similar conditions, as to length of time, density of bone, etc.

As a control the following experiment was done: A section of radius, 2.3 cm. long, was removed subperiosteally. Metal caps were placed on the bone stumps under the periosteum. The periosteal tube between the caps was filled with bits of iso-bone. The tube was closed. After 24 days the X-ray picture showed the area between the caps to be solidly filled with dense bone, in which some of the individual grafts could be seen. Microscopic examination showed the grafts themselves to be dead. There was new bone closely joining the grafts, which in some places was from the edges of the grafts and probably also from the periosteum.

Several points of interest were noted: That both auto- and iso-bone without periosteum, when transplanted into the periosteal tube, after subperiosteal resection of a rib, had had a stimulating effect on new bone formation from the periosteum and also from the rib ends. The stimulation of bone growth was much more marked than in the experiments in which periosteum was left on the transplant. That transplants of the same size under exactly the same conditions act quite differently, some apparently causing more stimulation than others. Some acted as a foreign body, some were undergoing absorption, some had disappeared, others were incorporated in the continuity of the bone. In no instance could new bone formation be demonstrated from the grafts themselves.

A piece of cow's horn and a section of dried iso-tendon were placed in the defects made by the subperiosteal resection of 2 cm. of two ribs. The periosteum was closed over the transplants. After 146 days the continuity of the ribs had been re-established. There was uniform thickening at the site of the transplants. The X-ray plate showed complete repair of the defect with absorption of the transplants. It is impossible to say whether the new bone was from the rib ends or from the periosteum.

A twisted piece of silver wire was placed in the defect made by subperiosteal resection of 2.4 cm. of a rib. The periosteum was closed over the wire. After 206 days the continuity of the rib had been restored. There was little thickening. The X-ray plate showed regeneration of the rib; the wire had been pushed to one side by the bone formation, which had gone on beneath it from the rib ends. Had the growth been from the periosteum the wire might have been surrounded by bone (Fig. 6).

A roll of insoluble gelatin was placed in the defect left by subperiosteal resection of 2.8 cm. of a rib. The periosteum was closed over it. After 215 days the continuity of the rib had not been restored; the gelatin was still present, and there was growth of bone from both rib stumps extending a short way into it. There had been no periosteal bone formation, and apparently none from the junction of periosteum and bone, where it is so frequently found.

In each experiment the periosteum was closed over the transplant. In only one was the defect not filled with new bone. This may have been due to the chemical structure of the gelatin. The new growth in each case was held in by the periosteal tube, and in each experiment the growth seemed to be from the bone ends rather than from the periosteum. The extrusion of the phalangeal bone with the formation of new bone from the rib ends beneath it, is very similar to the extrusion of the twisted silver wire by new bone formation. The cow-horn and dried iso-tendon transplants had been absorbed, and it was impossible to say whether the new bone formation was from the rib ends or from the periosteum.

REMARKS.—From this group of experiments we may conclude that either auto- or iso-bone, without periosteum, when they are transplanted into a periosteal tube after subperiosteal resection of a portion of a rib, will cause a very marked stimulation of bone growth, both from the rib ends and from the periosteum, in a comparatively short period of time. Transplants covered with periosteum, and also foreign bodies, seem to have no effect on the periosteum, but in each instance there was stimulation of growth from the rib ends.

Group V.

SILVER WIRE EXPERIMENTS.

Typical Experiment.—Fox terrier; about 6 months old. *Operation:* A zone of periosteum, 2.5 cm. wide, was removed from the shaft of the humerus, and a double twist of silver wire was wrapped snugly around the center of this area. After 133 days the wire was visible throughout its entire extent. It had become loose and in places lay in a shallow groove, apparently due to absorption caused by the pressure of the wire on the bone. The X-ray picture showed no new bone formation.

Summary.—Fourteen experiments were done on 8 dogs and on 6 rabbits. The femur was used in 6 experiments, the humerus in 5, and the radius in 3. In 7 experiments the silver wire was wrapped snugly around the bone after removal of the periosteum. The bone was curetted in 1 experiment; no precautions were taken against infection in 2, and in 1 of these the bone was also scraped. In 2 experiments the wire was placed over intact periosteum; in 1 over a fascia cuff, after removal of the periosteum; and in 1 subperiosteally. The zone of periosteum removed varied in width between 1 and 3 cm.

In 4 of the dog experiments the silver wire was placed around bone denuded of periosteum without disturbance of the bone itself. There was no new bone formation covering the wire, but rather an absorption ring under the wire, after 66, 91, 133 and 218 days. In 2 experiments the wire was placed over the intact periosteum, and a ring of absorption was present beneath the wire after 66 and 167 days. In 1 experiment the wire was placed around the bone as far as possible subperiosteally, and there was no new growth of bone after 167 days. In 1 experiment a cuff of fascia lata was sutured snugly around an area denuded of periosteum, and a wire ring placed over the fascia. After 66 days the specimen showed a slight constriction of the diameter of the shaft, due to the pressure of the snug fascia band (Fig. 7).

In 3 of the rabbit experiments the specimens were examined 44, 48 and 54 days after operation, and these can be grouped as to time. In no experiment was the wire covered by new bone for more than one-fourth of its length. In each experiment there was more bone growth posteriorly in the region from which the muscle attachments had been torn. In 1 experiment the loop was not covered in this region; in 1 it was covered by a thin plate of bone, through which it could be seen, and in 1 experiment it was buried in a thick, bony ridge. In the experiment in which no precautions against infection were taken, after 48 days a shallow ring of new bone had extended nearly all around the shaft, although it did not cover the loop.

In 3 other rabbit experiments, which can also be grouped as to time, the specimens were examined 121 and 122 days after operation. In 1 experiment, in which no precautions had been taken against infection, all but the twist and about one-sixth of the loop was covered by a thin layer of bone, through which the wire could be seen. In 1 experiment, in which the bone was roughly curetted, the twist and about one-fourth of the loop was still uncovered after 122 days. The remaining three-fourths of the loop was covered by a thin layer of bone, except posteriorly, where it was buried in a thick ridge of bone. This was simply an advanced stage of the 48 days' experiment spoken of above, which was carried out under similar conditions. In 1 experiment in which the bone was undisturbed after removal of the periosteum, the wire was visible everywhere, after 121 days, except posteriorly, where a thin band of new bone covered it. At several points around the shaft a slight ring of new bone had formed, but not as high as the wire loop (Fig. 8).

There was no visible thickening of the area from which the periosteum was stripped in the dog experiments, but there was definite thickening over this area in each instance in the experiments on rabbits. In fact, there seemed to be a somewhat greater tendency to bone growth in the rabbits in this group than in the dogs.

One is struck by the fact that the most extensive growth of new bone around the wire occurred in the experiments in which no precautions were taken against infection, and also in which the bone was curetted after removal of the periosteum. The thickest growth was always posteriorly, in the region from which the muscle attachment had been torn, or, in other words, where the bone has been most traumatized.

From these experiments we are led to believe that there is little if any new bone formed from the surface of a bone, after removal of the periosteum, unless the bone surface itself is irritated, either mechanically or by infection. That absorption occurs when silver wire is snugly applied around bone over intact periosteum, and also at times when around the denuded bone. That there is little if any new bone formation from the periosteum or bone, when a silver wire is placed around a bone subperiosteally. Thus it would seem that, in those experiments reported by others in which the ring was completely buried in new bone, either there was infection, or that the surface of the bone was much traumatized after, or during, the removal of the periosteum.

Clinically, I have noted that, when bones had been sutured with silver wire, there was usually absorption beneath the wire, rather than new bone formation over it.

Group VI.

THE IMPLANTATION OF BONE AND ALSO PERIOSTEUM INTO PREPARED DEFECTS IN THE SKULL.

Typical Experiment.—Mongrel dog; about 5 months old. *Operation:* After removal of the periosteum a button of bone 2 cm. in diameter was taken from the left temporal region. Into the defect were placed small bits of auto-rib which had been thoroughly scraped to remove all periosteum. After 35 days the defect was practically filled with a rigid crust of bone. The individual grafts could be plainly seen by transmitted light. X-ray and microscopic examination showed bone proliferation from the edges of the defect, and also from a number of the transplants. In several places there was solid junction between the edges and the grafts.

SUMMARY.—Nine experiments were done on dogs. In 2 experiments auto-periosteum was transplanted; in 4, split auto-rib without periosteum; in 1, auto-rib cut into bits; in 2, split iso-rib was used. In 1 experiment the defect was made with a trephine, and in 8 with the Hudson burr. The diameter of the defects varied between 1.1 to 2 cm. The transplants were placed on the dura in each instance.

The specimens were examined 35, 49, 93, 105 and 146 days after operation. In 2 experiments auto-periosteum was transplanted. In the 93 days' specimen there was a definite shadow on the X-ray plate, and microscopic examination showed bone formation. This periosteum had been roughly scraped from a rib, and may have had bone particles attached to it. The other periosteal transplant (49 days) was carefully removed, having no bone particles attached. In this experiment there was no bone formation. In both of these experiments there was bone growth from the edges of the defect.

In 2 experiments split iso-rib was transplanted, and in a corresponding opening on the other side of the skull split auto-rib was placed. In the 105 days' specimen the openings were entirely filled with bone, although by transmitted light the bone in some portions was much thinner than in others. The outline of the original grafts could be seen, and were firmly adherent to the edges of the defect and to each other. In the 146 days' experiment the defects were more solidly filled with bone, and there was less space between the grafts. The grafts themselves had been replaced by new bone. As to the clinical result after closing the defect, there was little to choose between the auto- and the iso-transplants.

In 2 experiments where split auto-rib without periosteum was used, the grafts were firmly attached to the edges of the defect, after 49 and 93 days. There was little, if any, proliferation of bone from the sides of the long strips. There was, however, proliferation of bone from the shorter strips, which had grown together and joined the longer strips. There was proliferation of bone from the edges of the defects. The grafts were apparently intact.

In 1 experiment small bits of auto-rib were placed here and there over the dura. After 35 days the defect was filled with bone. The X-ray picture showed proliferation of bone from the grafts and from the edges (Fig. 9).

These experiments show that transplants without periosteum retained their vitality, and that there was proliferation of bone from them, as well as from the edges of the defects. This was especially noticeable in the small fragments, as there was comparatively a much larger raw surface and consequently a better blood supply. The new bone seemed to come from the cut surfaces, rather than from the surface from which the periosteum was stripped. In 1 experiment there was new bone found in a periosteal strip which had been scraped from a rib (thus making the presence of bone particles possible), but in another experiment, where there was positively no bone attached to the periosteum, no new bone was formed. In 2 experiments where iso-grafts without periosteum had been transplanted, the outlines of the grafts were still present after 105 and 146 days. The transplants had been replaced by new bone from the edges following the line of the grafts. The stimulation of the edges of the defect seemed as great where iso-bone was transplanted as when auto-transplants were used; the closure of the defect was equally good in each.

GROUP VII.

AUTO-BONE IN SOFT PARTS.

TYPICAL EXPERIMENT.—Mongrel dog; about 1 year old. *Operation:* A section of rib, 2.9 cm. long, was removed subperiosteally and was transplanted between the ribs and the overlying muscle. After 206 days the bone was found snugly surrounded by connective tissue. It was much shorter and thinner than when transplanted, and had an irregular outline. The X-ray plate showed absorption everywhere, but much further advanced in some places than in others.

SUMMARY.—Twenty-five experiments were done. In 8, the bone was transplanted with its periosteum; in 17, without periosteum. In 11, sections of the ribs were used; in 4, portions of the radius; in 7, sections of the fibula; in 2, bone shavings from the skull, and in 1, an intact phalangeal bone. The bone fragments varied in length between .5 and 3 cm. The specimens were examined 11, 14, 19, 20, 55, 67, 94, 100, 104, 108, 113, 127, 128, 141, 143, 147, 206 and 207 days after operation.

There was little change in the transplants up to two weeks. After 19 days cross-sections of radius, .5 cm. long, without periosteum, both in subcutaneous tissue and in muscle, showed about the same degree of beginning absorption. After 20 days there was no sign of absorption shown by the X-ray picture in a section of the shaft of the fibula, 2.8 cm. long, with its periosteum, in muscle tissue. A section of auto-rib without periosteum, 1.5 cm. long, was sutured end to end to the stump of a cartilaginous rib, in which there was no bone. After 30 days the length was the same as when transplanted, but it was not quite so thick. The X-ray plate showed absorption from the edges.

A section of the shaft of the fibula, 3 cm. long, with its periosteum, was as flexible as a piece of rubber after 67 days. It was somewhat shorter than when transplanted, and about one-fourth as thick as the control fibula. This is very noticeable in the X-ray plate.

A section of rib without periosteum, 2.5 cm. long, was split into 4 pieces, which were placed side by side in muscle. After 100 days all of these pieces had joined in an irregular mass, and there had been growth of bone from the ends, and from several places in the length of the fragments. This framework of bone was rigid, but was very thin and almost transparent (Fig. 10).

Bone shavings from the skull mixed with blood had completely disappeared after 55 and 94 days.

A piece of split radius, 2 cm. long, without periosteum, placed in the subcutaneous tissue, had disappeared after 104 days. A section of rib, 1.8 cm. long, with a strip of periosteum, in muscle, had been absorbed after 108 days. An intact phalangeal bone, placed in muscle, still showed its out-

line in the X-ray plate, but was very thin and almost transparent, after the same length of time.

A section of the shaft of the fibula, 1.6 cm. long, without periosteum, was put in a blood-clot, and the mass was placed in a pocket in the subcutaneous tissue. The bone was found encapsulated 113 days later, but was much smaller and evidently undergoing absorption.

Two pieces of auto-rib, each 1.8 cm. long, without periosteum, were placed side by side in the subcutaneous tissue. After 127 days the fragments were found grown firmly together in an irregular mass. There was new growth of bone from one end of one fragment to the middle of the other. The transplants were very thin and nearly transparent. There had evidently been marked absorption going on also. When we compare this with the 100 days' experiment, we find the same picture, although the thickness of the specimen, where the whole thickness of the rib was used, was no greater than where the split rib was used.

A section of the shaft of the fibula, 1.2 cm. long, with its periosteum, was placed in the subcutaneous tissue. After 128 days a small portion of the bone was still present, although it was flexible and did not cast a shadow with the X-ray.

A section of the shaft of the fibula, 3 cm. long, with its periosteum, was removed. The periosteum was rolled back from each end for 1 cm., and 1 cm. of bone was cut off from each end, thus leaving 1 cm. of bone in the middle covered with periosteum. The cuffs of periosteum were then drawn up over the ends of the bone and twisted, so that the ends of the bone were also covered. This piece with periosteum, and the other two pieces of the same length without periosteum, were placed in muscle tissue. After 128 days the fragment covered with periosteum was rigid and apparently intact, except for slight rounding of the ends. The two other pieces were flexible and shorter, and showed evidences of absorption (Fig. 11).

A section of rib, 2 cm. long, without periosteum, in muscle, was almost absorbed in 141 days, only a tiny bit of bone remaining, which was also in process of absorption.

Two pieces of the shaft of the fibula, 1 cm. long, with periosteum, were still present after 141 days. The fragments were much smaller and showed marked evidence of absorption.

A section of rib, 1 cm. long, without periosteum, was surrounded by omentum, and 143 days later only a tiny bit of the bone remained. A section of rib of the same length, placed between peritoneum and muscle, had been absorbed in the same length of time. A section of rib, without periosteum, in the subcutaneous tissue, had evidently been absorbed after 147 days.

Two sections of rib, 1.8 cm. long, without periosteum, placed in muscle tissue, had been entirely absorbed in 207 days, while another section of rib, 2.9 cm. long, without periosteum, placed between muscle and ribs, could still be found after 207 days, although considerable absorption had taken place.

Remarks.—It is a difficult matter to draw conclusions from this group of experiments, as in some instances the findings seem to contradict each other. Those experiments, in which the bone was transplanted without periosteum, present very different pictures. Beginning absorption was noted as early as the 19th day. A section of rib, 2 cm. long, had disappeared in 104 days. On the other hand, portions of almost transparent bone were still present after 113, 128, 141, 143 and 207 days, whereas transplants of the same size in the same animals were absorbed in the same length of time. The rib transplants became flexible. In 3 experiments the transplants were placed close together. In 2 of these where sections of the whole rib in subcutaneous tissue and split rib in muscle were used, there was a definite new growth of bone and growing together of the fragments, but at the same time there were marked absorptive processes going on, and the resulting mass was as thin as paper and almost transparent. When 2 pieces of the fibula were placed side by side in muscle no such growth was noted.

Those experiments, in which the bone was transplanted with its periosteum, seem to show that the periosteum had a certain protective action on the transplant. Sections of fibula without periosteum had markedly softened and been reduced in size after 128 days, while a control section of fibula covered with periosteum remained practically intact after the same length of time. A section of rib with a strip of periosteum had been absorbed in 108 days, whereas an intact phalangeal bone was still present after the same length of time, although reduced in size.

In practically all of the transplants which remained at the time of examination there were signs of absorption, which were more or less marked. In only 2 of the entire group had there been any attempt at new bone formation, and even in these marked absorption was also going on. The transplants covered with periosteum seemed to be somewhat more resistant to absorption than those without periosteum. There was little difference in result, whether the transplants were placed in muscle or in subcutaneous tissue.

The blood supply probably has a good deal to do with the length of time a transplant can remain in soft parts without absorption. The type of bone used may also have some bearing on this point, a porous bone being easier to nourish than solid bone. If this were an important point, it would seem likely that the bone shavings with blood would have survived better than the solid pieces.

From the above experiments we feel justified in saying, that in the large majority of cases absorption takes place when a transplant of auto-bone, either with or without its periosteum, is placed in soft parts. We cannot say what would be the fate of those transplants which have grown together and produced new bone but, as absorption was going on in the bone and as the tendency of free bone in soft parts is to be absorbed, it seems logical that absorption would eventually have taken place. The lack of function probably also has a definite effect on ultimate absorption.

Group VIII.

iso-bone in soft parts.

Typical Experiment.—Mongrel dog; about 18 months old. *Operation:* A section of iso-radius, 2.4 cm. long, with its periosteum was placed in muscle tissue. After 151 days

the bone was still present, but considerably shortened. The X-ray plate showed that the portion covered with periosteum was still quite clear-cut in appearance, but that marked absorption was going on at each end.

SUMMARY.—Nine experiments were done. In 3 the bone was transplanted with its periosteum, and in 6 without the periosteum. In 4 the radius was used; the rib and the skull each in 2, and the fibula in 1. The longest bone fragment was 2.4 cm.; in 1 instance bone shavings were transplanted.

The specimens were examined 11, 13, 33, 74, 93, 100, 145, 147 and 151 days after operation. The transplants were placed in the subcutaneous tissue in 5 instances; in the muscle in 3, and in the abdominal cavity in 1 instance. Bone chips without periosteum from the radius, in subcutaneous tissue, had entirely disappeared after 100 days. Bone shavings from the skull, in subcutaneous tissue, had been absorbed after 93 days. A section of rib, 2.2 cm. long, without periosteum, in subcutaneous tissue, showed an area of liquefaction with only a very small portion of the bony structure remaining after 74 days. A cross-section of radius, 2.2 cm. long, with periosteum, in muscle, showed evidences of absorption from the ends after 33 days. A cross-section of radius, 2.4 cm. long, with periosteum, in muscle, was still present after 151 days, although there was considerable absorption, especially marked at the ends, while the area covered by periosteum was in much better condition. A split fragment of radius, 2 cm. long, without periosteum, in subcutaneous tissue, was still present after 145 days, although absorption was going on. A button of bone from the skull 2 cm. in diameter, including both tables, had been completely absorbed after 147 days.

REMARKS.—It is again difficult to draw definite conclusions in this group, except that absorption takes place, which would probably eventually lead to complete disappearance of even the transplants in fairly good condition.

A cross-section of the radius, with periosteum, showed beginning absorption from the ends after 33 days, whereas another section of the radius, with periosteum, was in a good state of preservation 151 days after transplantation, except that considerable absorption had taken place from the ends. The periosteum seemed to have some power of preventing absorption when it remained attached to the bone. On the other hand, a piece of split radius, without periosteum, was still present after 145 days, although absorption was progressing. In no instance was there any attempt at new bone formation from the transplants.

GROUP IX.

AUTO-BONE IN BONE DEFECT.

TYPICAL EXPERIMENT.—Mongrel dog; about 1 year old. *Operation:* A section of the shaft of the fibula, 2.8 cm. long, was excised, and into this defect was placed 2.8 cm. of rib without periosteum. No attempt was made to hold the fragments in apposition. After 87 days the defect seemed to be solidly filled, but there was slight motion at the upper end of the transplant. The X-ray plate showed the transplant to be considerably smaller in diameter. It was continuous with the lower fragment, where there was thickening. It had evidently been in contact with the upper fragment, but was not adherent, there being a false-joint formation. Microscopic examination showed an area of dead bone and some absorption, but as a whole vigorous, healthy bone.

This experiment shows that the transplant tends to assume the size of the bone into which it is transplanted. Also that the transplant lives and becomes a part of the host. There is little doubt but that the upper end would also have become firmly attached to the fibula, had the fragments been held in apposition.

SUMMARY.—Eight experiments were done on dogs. Defects were prepared in the radius in 2; in the fibula in 4; and in the humerus and femur each in 1 case. The periosteum was removed with the bone in each experiment. The resected bone varied between 1.4 and 4 cm. in length. The transplants were from the rib in 3; from the fibula and radius each in 2 cases, and from the femur in 1. They were without periosteum in 5, and with periosteum in 3. The specimens were examined 16, 64, 87, 92, 113, 130, 144 and 152 days after operation.

The periosteum was removed from the circumference of the femur, and an area of bone, 1.5 x .75 cm. long, was excised down to the marrow cavity. The bone was cut into small bits and was replaced in the defect, being held in position by a cuff of fascia lata, which was sutured snugly around the bone. After 130 days the bone under the fascia lata was definitely smaller than the corresponding area of the other femur. In one or two places the outline of the individual fragments could be seen, but the mass was flush with the surface of the bone, and had healed solidly in place. The fascia bundles, which had been purposely placed across the bone, could be plainly seen, and the fascia was more snugly adherent to the bone surface than was the adjacent periosteum.

This experiment shows that small fragments of bone, when replaced in a defect and prevented from extending beyond the surrounding bone, will heal smoothly into place. In this instance the fascia lata cuff acted as the limiting membrane. Fascia lata might be utilized, where periosteum is destroyed and overgrowth of bone is undesirable, as after operative work around joints.

A section of the shaft of the radius, 3.5 cm. long, was resected with its periosteum. The periosteum was removed thoroughly and the bone was cut into bits, which were placed in the muscle trough between the stumps. After 144 days the continuity of the radius was found to be re-established through an irregular mass of solid bone. There was compensatory thickening of the ulna, with a slight curve opposite the defect. The radius operated upon was .5 cm. shorter than the control. The X-ray plate showed atrophy of the upper fragment of the radius, with only slight proliferation from the stump. The lower fragment was normal, and there was a considerable amount of bone proliferation from the stump. There was bone formation around the bits of bone, which were solidly bound together.

The defect was filled with an irregular mass of solid bone which, while it conformed in a general way to the line of the bone, was not as thick as the shaft. There was atrophy of the upper fragment, which was probably due to interference with the artery. The transplants without periosteum had lived, and new bone formation had taken place around them. There was also new bone from the end of the lower stump, but not from the sides, as was the case in some instances in which the periosteum had been stripped back.

A section of the right radius, 1.5 cm. long, was resected with its periosteum. The periosteum was carefully removed and the bone was cut into bits. Some of the fragments were placed in a tube made of fascia lata. This tube was inserted into the defect, and the ends were drawn up like cuffs over the stumps and secured. After 152 days the defect was found filled with a mass of bone, which did not extend beyond the bone edges. Several of the bone fragments could be seen when the soft parts were removed. The lower radial stump was displaced posteriorly. There was compensatory thickening and also bowing of the ulna. The X-ray picture showed a number of the bone fragments still present, although some had been absorbed. Bone proliferation was slight from the grafts, although they were tightly bound to each other. There was some bone proliferation from both stumps.

In this experiment there was not much growth of bone from the radial stumps. Some of the grafts had survived, even though surrounded by a tough membrane, which would have interfered with the blood supply, for a time at least. The marked thickening of the ulna, to take care of the added weight, was noticeable.

The results from these experiments point to the fact that auto-grafts without periosteum, when cut into small bits, will live when placed in bone defects, and will produce new bone, which binds them together and also to the bone into which they are transplanted.

A section of the shaft of the humerus, 1.4 cm. long, with its periosteum, was excised, and to fill the defect a resected portion of a rib, 4 cm. long, without its periosteum, was forced into the marrow cavity of each fragment. The rib was not secured by pins, as the natural curve seemed to hold it firmly in place. The specimen was examined 16 days later. The rib had slipped from the lower fragment, but was tightly adherent to the upper fragment. The fragments were bound together quite firmly by a mass of callus. The X-ray plate showed no proliferation of bone from the cut surface of the lower fragment, although callus had already begun to form. A mass of callus was present around the transplant.

This illustrates the celerity with which new bone is formed and the remarkable strength of the healing of the fragments together, within this short time, in spite of the overlap. This overgrowth was probably due to the constant movement and irritation of the fragments.

A section of the shaft of the fibula, 4 cm. long, with its periosteum, was removed. Into the defect were placed two pieces of rib, each 2 cm. long. No attempt was made to hold the fragments in apposition. After 92 days the X-ray plate showed the defect to be filled, except for 3 mm., between the lower fragment and the transplant. The outline of the bone was somewhat irregular and the transplants had assumed the size of the fibula. It was difficult to make out the point of junction of the upper fragment and the transplant, and also where the transplants had joined. The lower portion of the lower transplant had been absorbed. Microscopic examination showed a few small areas of dead bone; elsewhere there was healthy, growing bone.

This experiment shows that two long transplants placed end to end in a bone defect will grow together, as well as do the tiny bits of bone previously mentioned.

A section of the shaft of the fibula, 3.5 cm. long, with its periosteum, was excised. After removal of a strip of the periosteum with some bone, the section was turned upside down and replaced. After 64 days the fragment was found healed in position and the continuity of the fibula was restored. The X-ray plate showed thickening of the ends of the stumps and the transplant at the point of junction. The transplant was somewhat irregular and thicker than the normal bone. There was firm healing at the lower junction. The line of healing could be seen at the uppper junction, although there was no motion.

A section of fibula, 2 cm. long, with its periosteum, was removed. Then bone was broken in three places without complete severance of the periosteum. It was then replaced upside down. After 113 days the continuity of the bone was found restored. The X-ray plate showed the inverted bone to be thicker and more irregular than the normal fibula. The line of fractures and junction with the fibula could not be made out (Fig. 12).

Remarks.—These experiments show that auto-bone, both with and without periosteum, may be successfully transplanted to fill defects in bone. Tiny bits, or one single piece, may be used. The transplant tends to assume the size of the bone into which it is transplanted.

Group X.

iso-bone in bone defects.

Typical Experiment.—Mongrel dog; about 8 months old. *Operation:* A section of the shaft of the radius, 3 cm. long, with its periosteum, was removed, and into the defect was placed a section of radius of the same length, without periosteum. After 121 days healing was complete, but the bone was shortened 1 cm. There was bending and thickening of the ulna opposite the defect. The X-ray plate showed the defect to be filled with irregular new bone from the bone ends, but the transplant had been absorbed.

Summary.— Seven experiments were done on dogs. The defects were prepared in the radius in 6 experiments, and in the fibula in 1. The periosteum was removed with the bone in each experiment. The resected bone varied between 1.8 and 3 cm. The transplants were obtained from the radius in 5, and from the rib and fibula in 1 case each. The specimens were examined 20, 27, 29, 74, 121, 123 and 126 days after operation.

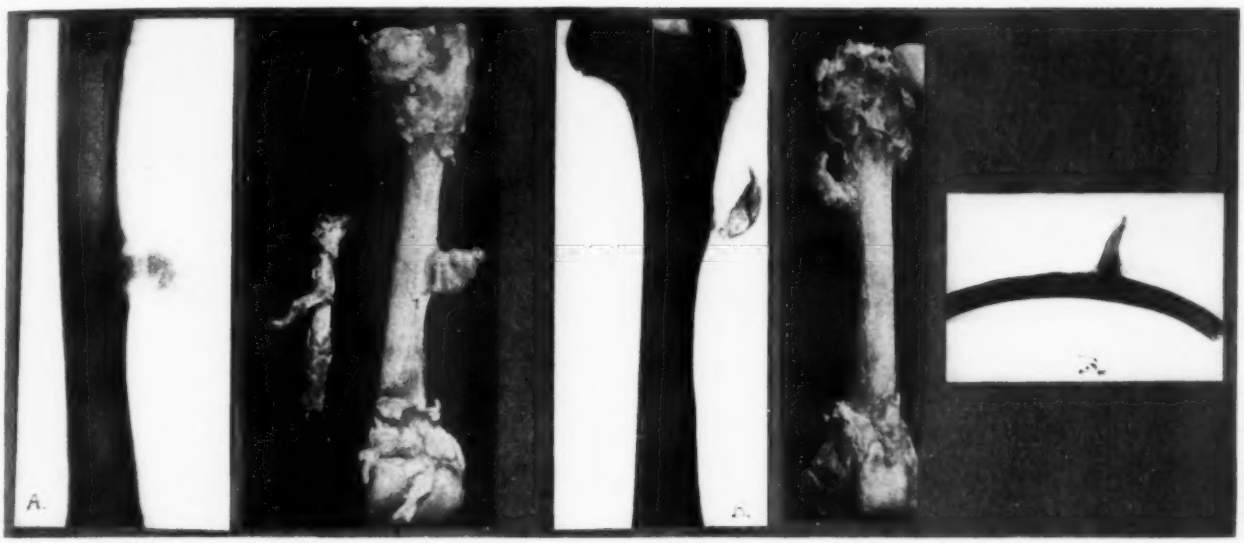

FIG. 1.—A pedunculated flap of periosteum with a thin film of bone was raised from the femur, and also from a rib. The soft parts were sutured beneath them. *A*. X-ray taken 34 days later. *B*. X-ray taken 50 days later.

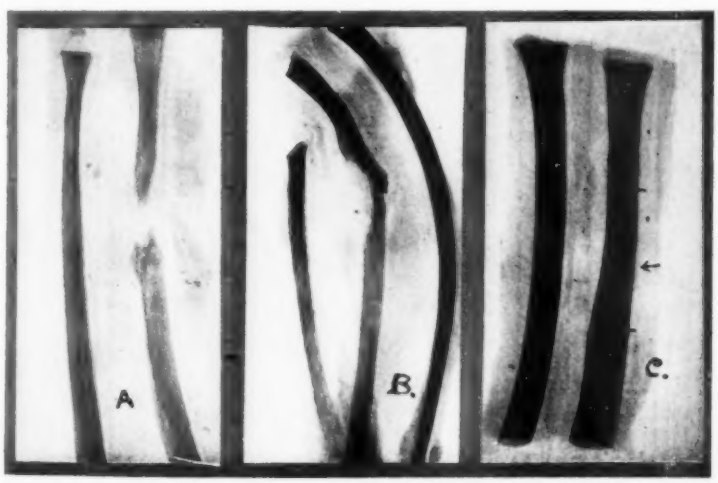

FIG. 2.—*A*. 87 days after operation. Extent of regeneration of a rib after a partial subperiosteal resection of 2.8 cm. The growth is only from the rib ends.

B. 105 days after operation. Extent of regeneration of a rib after partial subperiosteal resection of 2.1 cm. The irregular growth is from the rib ends. The periosteal tube was not closed in either *A* or *B*.

C. 100 days after operation. The regenerated rib after partial subperiosteal resection of 3 cm. The periosteal tube was closed and the growth has evidently followed the tube.

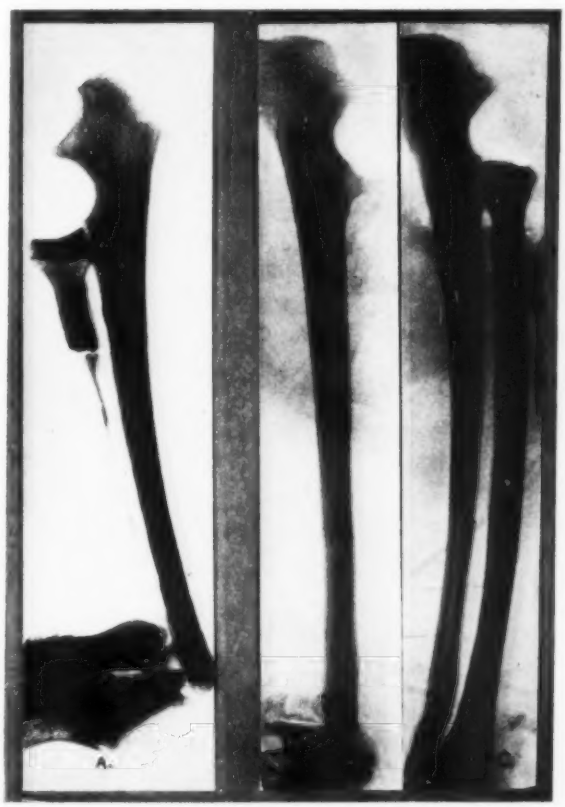

FIG. 3.—*A*. A section of radius, 5.8 cm. long, was excised subperiosteally. No attempt was made to remove tiny particles of bone, which may have adhered to the line of muscle attachment. X-ray taken 31 days later.

B. The entire radius including the articulating surfaces was excised subperiosteally. No visible bone particles were allowed to remain. X-ray taken 129 days later.

C. Control.

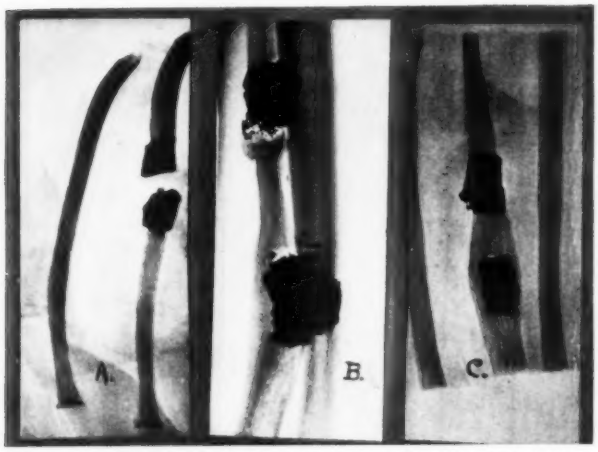

FIG. 4.—*A*. Metal caps placed on the stumps, after subperiosteal resection of 1.5 cm. of a rib. The tube between the caps was dry. The periosteum was closed over the caps. X-ray taken 28 days later.

B. Metal caps placed on stumps after subperiosteal resection of 2.5 cm. of shaft of radius. The tube between the caps was dry. The periosteum was not closed. X-ray taken 106 days later.

C. Metal caps on the stumps after subperiosteal resection of 2 cm. of a rib. A blood-clot was placed in the tube between the caps, and the periosteum was closed. X-ray taken 141 days later.

In *A* there is no attempt at bone formation from the periosteum. In *B* the new bone has formed from the side of the shaft back of the cap. In *C* the same thing has occurred, although the X-ray from above does not show it.

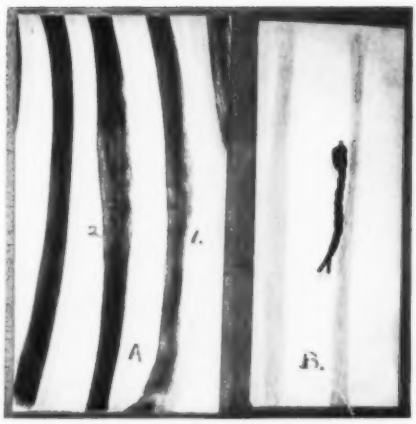

FIG. 6.—*A*. A piece of dried iso-tendon (1) and a piece of boiled cow's horn (2), were placed in defects made by the subperiosteal resection of 2 cm. of two ribs. The periosteum was closed over the transplants. X-ray 146 days later.

B. A piece of twisted silver wire was placed in a defect made by the subperiosteal resection of 2.4 cm. of a rib. The periosteum was closed over the wire. X-ray 206 days later.

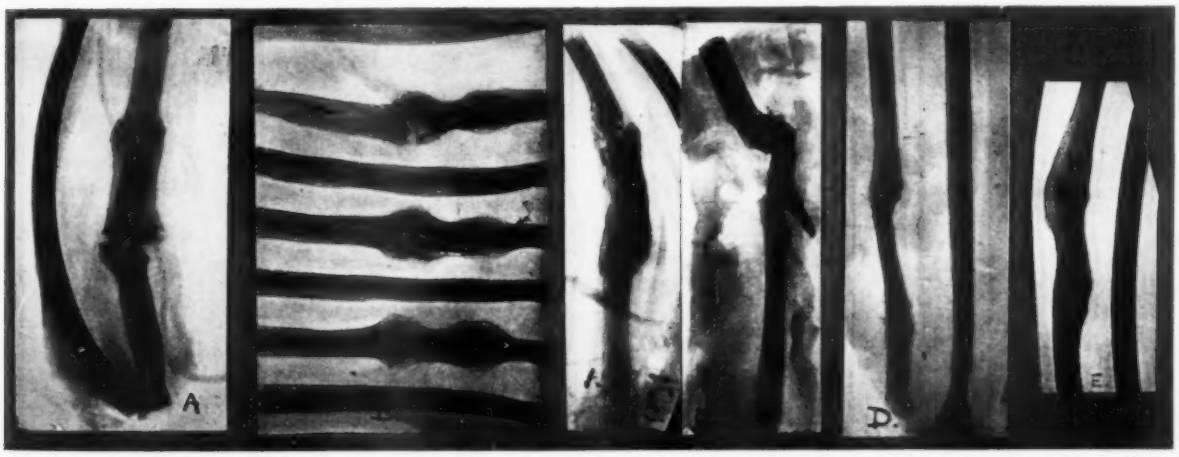

FIG. 5.—*A*. Auto-skull-bone, without periosteum, in defect left by subperiosteal resection of 2 cm. of a rib. The periosteum was closed. X-ray 35 days later.

B. Sections of iso-rib, without periosteum, in defects left by subperiosteal resection of portions of 3 ribs. The periosteum was closed over each. X-ray taken 44 days later.

C. Auto-bone shavings with blood in defect after subperiosteal resection of a rib. The periosteum was not closed in either experiment. X-ray after (1) 50 days; (2) 94 days.

D. Auto-fibula with its periosteum in the defect, after subperiosteal resection of 2 cm. of a rib. The periosteum was closed over it. X-ray taken 93 days later.

E. A split piece of iso-humerus without periosteum put into the defect after subperiosteal resection of 2.2 cm. of a rib. The periosteum was closed over the transplant. X-ray 100 days later.

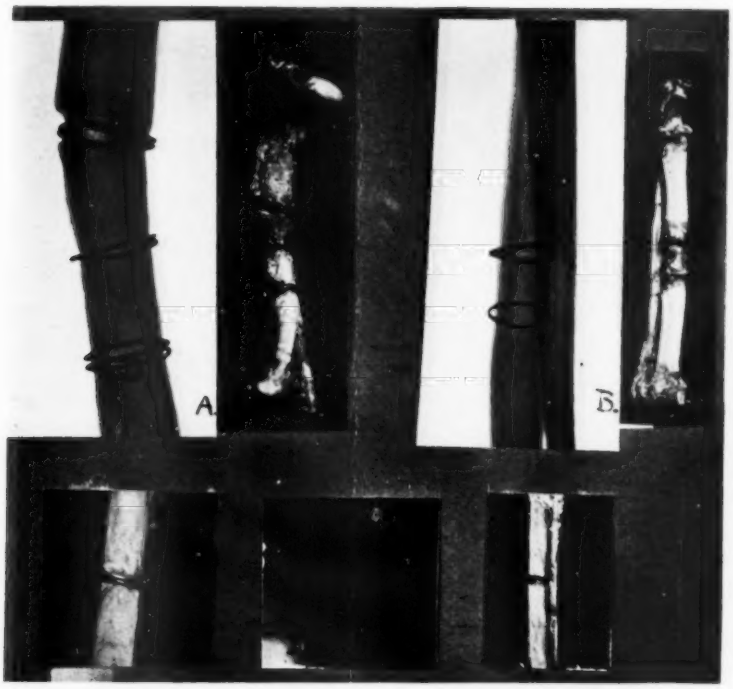

FIG. 7.—Silver wire experiments on dogs. *A*. The upper wire was placed over intact periosteum; the middle wire was placed over a cuff of fascia lata, after removal of the periosteum; the lower wire was placed over denuded bone. X-ray 66 days later.
B. The upper wire was placed over undisturbed periosteum; the lower wire around the bone subperiosteally. X-ray 167 days later.
Silver wire around denuded bone. *C*, after 91 days. *D*, after 133 days. *E*, after 218 days.

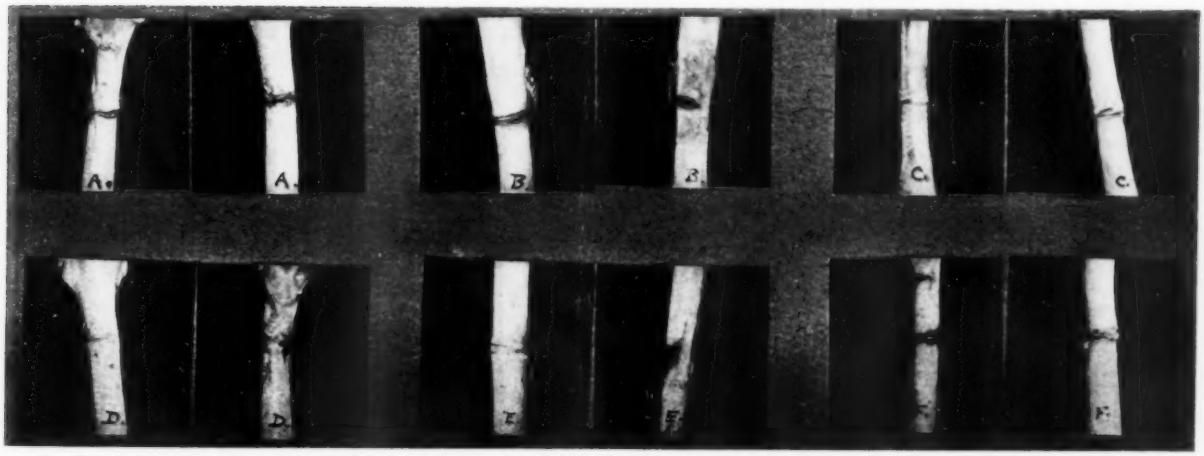

FIG. 8.—Silver wire experiments on rabbits. Front and back views. Silver wire was placed around the femur, after removal of zones of periosteum from 1.5 to 4 cm. wide. *A*, after 44 days. *B*, after 48 days. *C*, after 54 days. *D*, after 121 days. *E*, after 122 days. *F*, after 122 days. In *A* and *D* no precautions were taken against infection. In *E* the bone was curetted before the wire was applied.

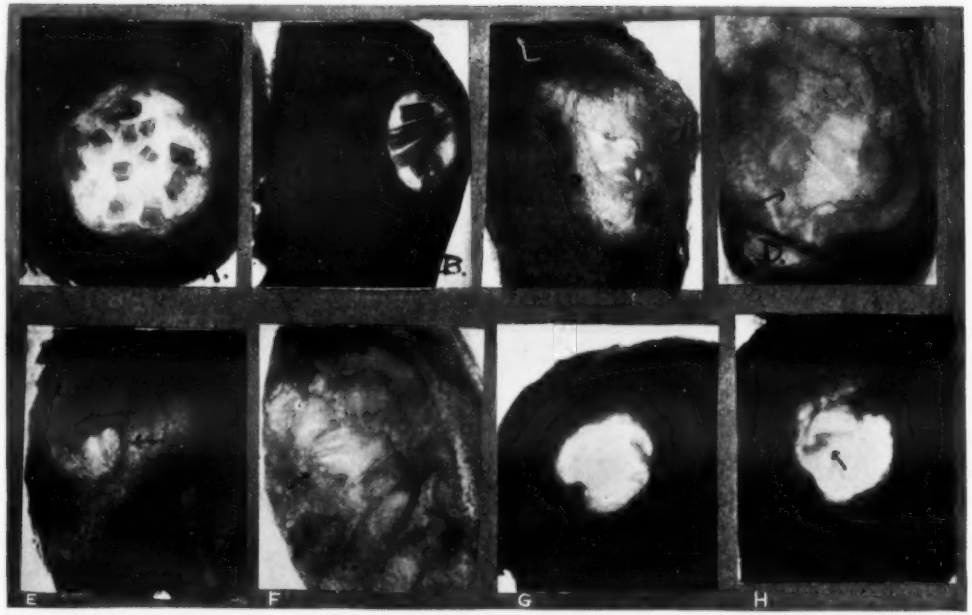

FIG. 9.—Split auto-rib without periosteum in skull defects. *A*, after 35 days. *B*, after 49 days. *C*, after 105 days. *D*, after 146 days. Split iso-rib in skull defect. *E*, after 105 days. *F*, after 146 days. Auto-periosteum in skull defects. *G*, after 49 days. *H*, after 93 days.

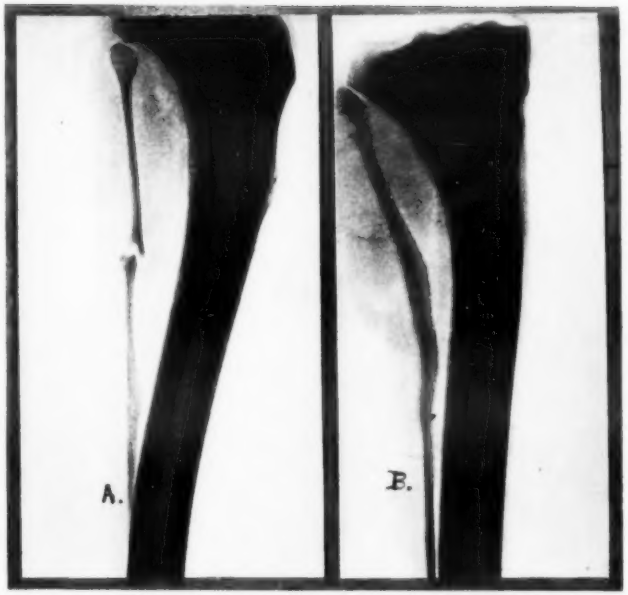

FIG. 12.—*A*. A section of auto-rib, 2.8 cm. long, without periosteum was placed in a defect of the same length in the fibula. X-ray 87 days later.

B. A section of fibula, 2 cm. long with its periosteum, was removed. It was broken into 3 pieces transversely without entire severance of the periosteum, and was replaced upside down. X-ray 113 days later.

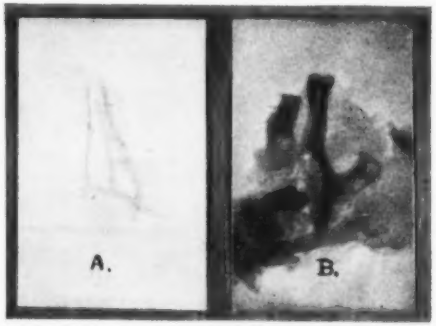

FIG. 10.—*A*. A piece of auto-rib, 2.4 cm. long, without periosteum, was split into 4 pieces which were placed side by side in the soft parts. X-ray 100 days later.

B. Two pieces of auto-rib, 1.8 cm. long, without periosteum, were placed side by side in the soft parts. X-ray 127 days later.

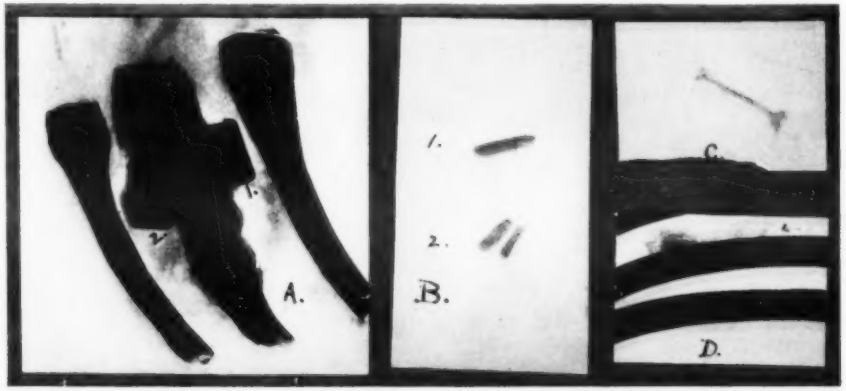

FIG. 11.—*A*. Sections of auto-radius, each .75 cm. long, were placed on a denuded rib. 1 was covered with periosteum : 2 was denuded. The wound became infected. The transplant covered with periosteum is still clear cut and has resisted absorption much better than the transplant without periosteum. X-ray 20 days later.

B. A section of auto-fibula, 3 cm. long, was excised, and the periosteum was stripped back from each end. 1 cm. of denuded bone was cut off from each end. The periosteum was then drawn over the ends of the undisturbed portion, and twisted, the transplant being thus entirely covered with periosteum. The 3 pieces were then buried in muscle. 1, The specimen covered with periosteum was rigid and intact, except for absorption at the ends. 2, The 2 pieces without periosteum were flexible and showed evidences of absorption. X-ray 128 days later.

C. An intact auto-phalangeal bone was placed in the soft parts. X-ray 108 days later.

D. A section of auto-rib, 2.9 cm. long, was placed in the soft parts. X-ray 206 days later.

In 2 experiments the transplants were covered with periosteum. In 1, after 20 days, the transplant seemed intact, and there was quite firm union with the upper fragment. The X-ray plate showed the growth to be from the upper fragment. In the other, after 29 days, the transplant was intact and firmly adherent. The X-ray plate showed marked proliferation of bone from the sides and cut surfaces of both radial stumps, and a definite attempt to surround the transplant with new bone. There was no proliferation of bone from the transplant, and no evidence of absorption. These animals died of pneumonia, so that the specimens were examined sooner than was intended.

One experiment, in which the transplant was not covered with periosteum, may be compared with that just described. After 27 days the transplant was found to be tightly adherent to the upper radial stump. The X-ray plate showed slight proliferation of bone from the radial stumps and possibly a slight thickening of the side of the transplant. The growth of bone from the radial stumps was much more marked in the specimen in which the transplant had been covered with periosteum. This may have been due to the fact that the transplant with periosteum was forced into the defect, while the transplant without periosteum was a trifle shorter than the defect. Both transplants seemed in equally good condition.

In 4 other experiments the transplants were without periosteum. In 1 a section of rib 2.2 cm. long, in a radial defect, was still demonstrable after 74 days, but was evidently acting as a scaffold for the formation of bone from the radial fragments, and not from the transplant itself. The radius was shortened. The transplant was of normal thickness in the center of the defect, but was replaced by much thicker bone at its ends. The transplant itself was 1 cm. shorter than when transplanted. The other experiments without periosteum (121, 123 and 126 days) showed disappearance of the transplant in each instance, with shortening and bending of the bone and compensatory thickening of the ulna opposite the defect. There was marked growth of bone from the bone stumps in each instance, which was significant, when compared with the slight growth of bone from the stumps when no bone was placed in the defect.

This group leads us to believe that iso-bone in a bone defect stimulates the growth of bone from the bone stumps; that the bone acts as a sort of scaffold to the growth of new bone, from the living bone stumps; that there is shortening of the bone into which the transplant is placed, and that there is ultimate absorption of the transplant.

GROUP XI.

MISCELLANEOUS EXPERIMENTS.

The periosteum was removed from the surface of a rib, and on the denuded area two sections of the radius were secured, each being .75 cm. long. One was covered with periosteum; the other was denuded. The wound became infected and the specimen was examined 20 days later. There was marked thickening of the denuded rib, which had been caused by the irritative action of the infection, and also by the friction of the transplants against it. The X-ray plate showed that the transplant without periosteum was smaller and showed much greater evidence of absorption than the transplant with periosteum. This seems to indicate that the periosteum had had some protective influence against absorption due to infection.

An area of bone from the surface of the femur, 3 x 1 cm. in diameter, was removed down to the marrow cavity, after the periosteum had been stripped from the circumference of the femur in this region. The marrow and endosteum were curetted as thoroughly as possible. The bone strip was scraped and placed on the denuded femur opposite the defect, with the marrow side to the bone, and was held in position by the surrounding soft parts. After 93 days the transplant, much roughened and thickened, was found tightly adherent to the femur. There was also thickening of the femur adjacent to the transplant. The area from which the transplant was taken was marked by a depression which measured 2.7 x .5 cm. in diameter. Along its edges was a rim of new bone. There was also an irregular growth of new bone lining the cavity, but not filling it. Both femurs were of the same length, but the bone which had been operated upon was much thicker and more irregular in appearance. The X-ray plate showed new growth of bone along the femur beneath and beyond the graft, and from the graft itself. The graft showed no sign of absorption and was of the same length as when transplanted.

This shows that auto-bone without periosteum, placed against denuded bone, will live and produce new bone, and will stimulate the bone along which it is placed to produce new bone. In this way a weakened bone might be reinforced. It also shows that there is new growth of bone from the surface of denuded bone, when in contact with denuded bone. This is in marked contrast to the slight overgrowth of bone which occurred when the periosteum alone, or with bone shavings, was removed. There was also growth of bone from the cut surfaces in the shaft of the bone, and also from the surface of the marrow cavity, after a curetting of the marrow and endosteum.

After removal of the periosteum an area of bone, 1 x 1.5 cm., was chiseled out of the shaft of the femur down to the marrow cavity. After 100 days the site of the defect was marked by a depression filled with bone. On cross-section, there was an overgrowth of bone extending into the medullary cavity, probably from the endosteum. This is interesting, as there had been no attempt whatever at overgrowth of bone around the edges of the defect, or from the area denuded of periosteum.

A section of radius, 3.2 cm. long, with its periosteum, was removed, and the periosteum was stripped from the stumps. A celluloid tube was placed around the stumps and so as to fill the defect. After 151 days the celluloid tube was found to be intact. The radius still had a defect 1.6 cm. long. The X-ray plate showed a healing fracture in the ulna at the lowest level of the defect. There was also an irregular, conical outgrowth of bone from each radial stump, which had evidently grown into the celluloid tube. One is struck by the slowness of the growth of bone from the radial stumps

during this length of time; this is very marked when compared with the growth of bone from the radial stumps when either auto- or iso-bone is placed in the defect.

At this time it might be well to remark on the very sluggish growth of new bone from bone stumps, after partial resection of a bone with its periosteum. This was noted in a number of experiments; it is astonishingly slow, being very little more marked after six months than after six weeks.

CONCLUSIONS.

Free periosteal transplants did not produce bone in the large majority of experiments, even though osteoblasts were adherent to the transplants.

Pedunculated flaps of periosteum did not produce new bone.

Free periosteal transplants and pedunculated periosteal flaps, with bone shavings attached, produced bone in each experiment. From this we may surmise that bone particles had been accidentally transplanted in those experiments in which bone was found after the transplantation of free periosteum.

The removal of periosteum had little, if any, effect on the nutrition of a bone. The surface from which the periosteum was removed showed very little overgrowth of bone, unless there had been considerable irritation of that surface, either by trauma or by infection. The area from which the periosteum had been taken was covered with a thin, very adherent fibrous membrane; or the muscle tissue was adherent to the denuded area.

Absorption occurred when a silver ring was snugly applied around a bone over the periosteum, and also at times when it was applied around denuded bone. There was no new bone formed from either the periosteum or bone, when a silver ring was placed around a bone beneath the periosteum.

Both auto- and iso-bone, without periosteum, were effective in repairing skull defects.

Auto- and iso-bone, without periosteum, when transplanted into the periosteal tube after subperiosteal resection of a rib, caused stimulation of bone growth from the periosteum and also from the rib ends.

Transplants, covered with periosteum and also foreign bodies, stimulated bone-growth only from the rib ends.

Transplants of the same size in a periosteal tube, after subperiosteal resection, under exactly the same conditions, acted quite differently.

After subperiosteal resection of a portion of a bone, the growth of bone in repairing the defect was from the bone stumps, the periosteum acting as a limiting membrane.

Auto-bone, both with and without periosteum, lived and was successfully transplanted to fill defects in bone. Clinically, it is advisable to transplant bone covered, in part at least, with periosteum.

Iso-bone in a bone defect acted as a scaffold for the growth of new bone from the living bone stumps, but there was ultimate absorption of the transplant.

Auto-bone, both with and without periosteum, was absorbed when transplanted into soft parts. The periosteum seemed to have some protective influence against early absorption. The fate of those transplants which had grown together and produced new bone is doubtful, but as absorption was going on, and as the tendency of free bone in the soft parts was to be absorbed, it seems probable that absorption would eventually have occurred.

The same may be said of iso-bone in soft parts, except that in no instance was any new bone formed from the transplant.

THE JONATHAN HUTCHINSON ICONOGRAPHY.

A PRELIMINARY NOTE.

By William Osler.

I was delighted to hear that through the generosity of Mr. W. A. Marburg, already a liberal donor, The Johns Hopkins Medical School had secured the Jonathan Hutchinson collection of original drawings, colored plates and photographs illustrating clinical medicine and surgery. For a long time I have known the collection, and frequently had the privilege of a demonstration of certain parts by Sir Jonathan himself. In 1900 he gave it as a clinical museum to the Medical Graduate College, and it was my privilege to deliver the opening address on that occasion. The times have been too much for the college, which recently dissolved, and the collection came into the market. I may be permitted to quote a paragraph from that address about Sir Jonathan and his collection:

You have been fortunate in having associated with your college (Medical Graduate College and Polyclinic, England) a man with a truly Hunterian mind. In the broad scope of his work, in the untiring zeal with which he has studied the natural phenomena of disease, in his love for specimens and collections, Mr. Jonathan Hutchinson bears a strong likeness to the immortal Hunter. No individual contributor in this country has made so many careful observations upon so many diseases. He is the only great generalized specialist which the profession has produced, and his works are a storehouse upon which the surgeon, the physician, the neurologist, the dermatologist and other specialists freely draw. When anything turns up which is anomalous or peculiar, anything upon which the text-books are silent and the systems and cyclopædias are dumb, I tell my students to turn to the volumes of Mr. Hutchinson's *Archives of Surgery*, as, if it is not mentioned in them, it surely is something very much out of the common. It is very fortunate that his collection will be kept together, as it will be of great service to students from all parts of the world. In one respect it is unique, pictorial and clinical, not anatomical and pathological, and it will remain a worthy monument to the zeal and perseverance of a remarkable man, a man who has secured the homage of a larger number of clinical workers than any Englishman of his generation.[1]

[1] The Importance of Post-Graduate Study, Lancet, 1900.

The collection consists of:

(1) Original colored drawings, of which there are many hundreds.

(2) Colored plates taken from atlases, books and memoirs.

(3) Engravings, woodcuts, photographs and pencil sketches, very often with the letterpress or manuscript notes attached.

The collection illustrates the whole range of medicine and surgery. Very many of the drawings were specially prepared for the *Atlas of Skin Diseases,* which Sir Jonathan edited for the New Sydenham Society; for the *Atlas of Clinical Medicine and Pathology,* which he edited for the same society; for his *Atlas of Clinical Surgery* and for his well-known *Archives of Surgery,* a copy of which he sent to our library. The drawings are classified; one group, comprising more than 5000, are in large paper envelopes; the other, an even larger number, in large cardboard portfolios. While they illustrate particularly the life work of the collector in syphilis and skin diseases, there is scarcely a department of medicine that has not one or two portfolios devoted to it. It is probably the most remarkable iconography on syphilis ever made; portfolio after portfolio is filled with illustrations on every variety of the lesions of this protean disease. Take at random the labels of some of the rarer items: circumcision chancres, syphilitic herpes, recurrent chancres, vaccination syphilis (a very-fully-dealt-with subject), keloid after syphilis.

The illustrations on skin diseases outnumber the others, and the collection illustrates particularly the rarer forms. Sir Jonathan was deeply interested in leprosy and in lupus, every possible phase of which is here depicted. Then, many portfolios are devoted to Reynaud's disease, and I see in one portfolio the original drawings illustrating Barlow's paper. Yaws, tattooing, gout, vascular tumors, chloroma, rhinoscleroma, Kaposi's disease, Darier's disease, Biett's disease, nevus, acromegaly, hermaphroditism (in which portfolio I see the original drawings of Partridge's rare case of double penis) anomalies, deformities—all the odd and peculiar deviations in form and structure are represented. A doctor with a case in any way out of the ordinary would be sure to write to Sir Jonathan, who would at once have a photograph or colored drawing made, so that the iconography represents the experience of his long life.

How may the collection be best utilized? It should first be catalogued, the plates identified, which could easily be done from the well-known atlases and from the works already mentioned. The unpublished colored drawings should be separately indexed. The primary business of a medical student is to get a knowledge of disease, and, if used by teachers, this collection will be of great value in helping them to demonstrate both the common and the rarer types. For the departments of syphilis and of skin diseases it will be invaluable, and there is no reason why the collection should not be distributed where it will be most helpful. In any case, it should be in the hospital side of the medical school library, where the treasures should be made freely accessible to the medical student.

AN ACCOUNT OF THE SURGERY AND THE SURGEONS OF THE AMERICAN REVOLUTION.[1]

By WALTER B. PLATT, M. D., F. R. C. S. (Eng.).

While thinking over matters connected with the American Revolution it occurred to me that I had very little definite knowledge concerning the medical and surgical work of the army during that war; the men engaged in it, or of their methods. While it is too much to believe that there are many situated as I was in this regard, there may be physicians to whom such facts as I have been able to gather may be in part new. On this supposition I have ventured to prepare this paper.

It was a matter of interest at that time that I could find no work in the library of the Army Medical Museum under the heading "Surgery of the American Revolution," or any similar title. After some inquiry I found several books under other names bearing on this subject. They were those of Dr. Harvey Brown on organization mainly; of Toner, dealing principally with the personnel; of Thacher containing a general sketch of the work of the surgeons, and of Dr. John Jones (1776).[2] I believe these four works with their references contain the greater part of the material that is available and reliable.

The beginning of the medical department of the American army in the Revolutionary War, and thus of army surgery in this country on an organized basis, was when a large number of citizens of all classes, and among them a number of physicians, assembled at Cambridge, Mass., on the occasion of the siege of Boston, directly after the battle of Lexington, to lend what aid they could. At that time there was nothing in existence to provide for the care of the sick and wounded, and the Second Provincial Congress of Massachusetts, in May, 1775, saw the urgent need of doing something in their behalf.

The first step was taken when they ordered "That the President *pro tem.*, with Drs. Church, Taylor, Holten and Dunsmore, be appointed a committee to examine such persons who are or who may be recommended as surgeons for the army

[1] Read before The Johns Hopkins Historical Club.

[2] Historical Notes concerning the Medical Department of the United States Army. By Harvey W. Brown, Assistant Surgeon U. S. A. 1873.

Medical Men of the Revolution. By Dr. John M. Toner, Philadelphia, 1876.

Thacher's Military Journal during the Revolutionary War, from 1775 to 1783. Second Ed., Boston, 1827.

Plain and concise practical remarks on the treatment of wounds and fractures, to which is added an appendix on camp and military hospitals; principally designed for the use of young military and naval surgeons in North America. By Dr. John Jones. Philadelphia, 1776.

now forming in the Colony," and "*Resolved:* That persons recommended by commanding officers of the several regiments be appointed surgeons of their several regiments provided they appear duly qualified upon examination." Drs. Whiting, Bayliss, Hall, and Jones were added to this committee not long afterward. We learn from Thacher's "Military Journal during the American Revolutionary War" that sixteen applied the first day and that ten of these were accepted.

The first military hospital of the war was established directly after the battle of Bunker Hill in a number of private houses, and the man in charge was Dr. John Warren, the brother of Dr. Joseph Warren who commanded the troops on that occasion. It may be well to state at this time that the words "hospital service," as used in Acts of Congress and formal communications, usually meant medical bureau or department, and not simply a hospital in the ordinary acceptation of the word. Soon after Dr. Isaac Foster, of Cambridge, succeeded Dr. Warren, and was made Deputy Director-General; and other hospitals were established at Roxbury and Watertown, besides a fourth for smallpox cases.

The organization was upon a simple plan. Each hospital had two surgeons and two surgeon's mates, while each regiment had one surgeon and two surgeon's mates. Colonels of the regiments had the nomination of the surgeons, and the surgeons might nominate their mates.

The pay of the hospital surgeons was fixed at eight pounds per month, and that of the mates at four pounds ten shillings per month.

As might be imagined, the plan of nomination by the colonels did not improve the efficiency of the surgeons, although a number of very genial fellows were doubtless brought to the front by this system. The lack of efficiency was so manifest that Congress speedily overhauled the medical department, and Gen. Washington, who saw the extreme importance of maintaining the highest excellence in this branch of the army, sent a message to the president of Congress in which he said that there was lack of discipline among the surgeons, that disputes and contentions abounded, and that he would like to have the department put under proper regulations. This spirit of contention, indeed, was the chief bane of the army and hospital surgeons from the beginning to the end of the war, and seemed to be the habit of the time in the profession the world over. I believe this was due less to the character of the physicians than to the condition of medicine at that time, in which there was too much metaphysics and too little physics, and because men were trying to deal with purely physical conditions on a metaphysical basis. Physicians had little that was real to stand upon, apart from the splendid achievements of anatomy, and their foundations in medicine were frequently thrown down because built upon speculation instead of fact; the essence of disease was regarded a matter to be settled by argument, and its treatment was reasoned out in the study instead of in the laboratory or by the bedside. Consequently they argued and disputed, and not being convinced, fought with wordy weapons.

Dr. Benjamin Church, the first head of the hospital department of the army, was a man of great ability, dignity and magnetism, apparently an ardent patriot, and certainly a fine orator. After his appointment, however, he was an uncommon failure from every standpoint. He turned out to be quarrelsome, complaining, and negligent; and worst of all, was finally detected in sending secret messages to the British by the hand of a woman. For this, a crime deserving death, he suffered a long imprisonment. Being finally allowed to leave the country, he sailed for the West Indies on a ship which was lost at sea.

His successor in office was likewise a man of great ability, ripe culture, and considerable experience; for, Dr. John Morgan of Philadelphia was a remarkable man. He had been a pupil of John Hunter and returning to America had united with Shippen and the Bonds in founding a medical school. His previous military experience as a surgeon had been acquired in the French and Indian War. On taking charge, he found the hospitals full of cases which ought to have been cared for in the field. He cleaned up the service as well as the hospitals, sending back many surgeons to the field, and soldiers, who were able to fight, to the front. A number of surgeons unqualified for the work he discharged and made every effort to improve the service.

In December, 1775, Congress raised the pay of surgeons to $25 per month and of surgeon's mates to $18.[1] The campaign against Quebec was not the conspicuous success it had been in the French and Indian War; the army found itself short of hospital supplies, with an abundance of cases of smallpox and nostalgia on hand; two diseases we hear more of in the early days of our country than at the present time. However, the health of the troops about Cambridge continued good during the summer of 1775, until the arrival of troops from the Middle and Southern States, when dysentery, typhus and typhoid began to claim many victims. The seat of war was now transferred further south with headquarters at New York, and the hospitals, which had been merely receptacles for the sick, with little to make them habitable, had plenty of supplies.

Morgan would have made a capital hospital superintendent, for his great talent was again shown in cleaning out the hospitals, and reducing the number of inmates in his district to eighty. Once more there was friction between the army surgeons and the hospital surgeons, the former thinking that the latter had an easy berth with plenty of supplies, which they withheld from those in the field. Only army rations were given to the sick, and of course these were entirely unfit for men suffering with suppurative fever and dysentery.

In the summer of 1776, almost at the outset of the war, there was again a dearth of hospital supplies, about which Dr. Stringer made complaint to Gen. Gates. The limits of authority of the different medical officers were so ill-defined, that friction could not fail to take place constantly, and much of the time which could have been better employed was taken up with complaints of each other. Dr. Stringer went directly to Congress to complain of Dr. Morgan, the final result being the dismissal of both from the service. The surgeons certainly should not have been held responsible for the scarcity of hospital supplies. We learn that the supply of bandages at this time was not sufficient for fifty men; there was no straw for bedding for the sick, and the army was on the verge of mutiny.

[1] This probably refers to the field, not to the hospital, surgeons.

Gen. Gates wrote that the neglect was shameful, and Gen. Greene complained bitterly of the treatment of his soldiers because of the incompetence of the surgeons.

As far as Dr. Morgan is concerned, he seems to have done what he could, and although finally vindicated by Congress, he died of a broken heart by reason of the injustice done him. Dr. Benjamin Rush, the father of American medicine, says he was respected by the officers and beloved by the soldiers, and that "he had an uncommon capacity for acquiring knowledge, a memory extensive and accurate, and was intimately acquainted with the Latin and Greek classics. He had read much in medicine, and in all his pursuits he was indefatigable and persevering. He evinced an amiable and exemplary tenderness toward the sick." His failures, Dr. Rush believed, were due to causes beyond his control.

Dr. Shippen devised a plan of organization taken from that of the British Army and better than the one then in existence, but too complex for American use at that time. It received the commendation of Gen. Washington. It was as follows:

Dr. Wm. Shippen, Jr., was chosen, by unanimous ballot of the thirteen States, Director-General of all the military hospitals for the armies of the United States.

Dr. Walter Jones, Physician-General of the Hospital in the Middle Department.

Dr. Benj. Rush, Surgeon-General of the Hospital in the Middle Department.

Dr. John Cochran, Physician and Surgeon-General of the Army in the Middle Department.

Dr. Isaac Foster, Deputy Director-General of the Hospital in the Eastern Department.

Dr. Ammi Ruhamah Cutter, Physician-General of the Hospital in the Eastern Department.

Dr. Philip Turner, Surgeon-General of the Hospital in the Eastern Department.

Dr. William Burnet, Physician and Surgeon-General of the army in the Eastern Department.

Dr. Jonathan Potts, Deputy Director-General of the Hospital in the Northern Department.

Dr. Malachi Treat, Physician-General, in the same.

Dr. Forgue, Surgeon-General, in the same.

Dr. John Bartlett, Physician and Surgeon-General of the army of the Northern Department.

Washington always recognized the importance of the surgical service of the army and recommended a liberal compensation to surgeons. In a letter to John Hancock dated March 14, 1777, he writes, "There is one thing which claims in my opinion the earliest attention of Congress, I mean the pay of regimental surgeons and that of their mates. Those appointments are so essential that they cannot be done without. Their pay in the first instance, is so low, so inadequate to the services which should be performed, that no man sustaining the character of a gentleman and who has the least ability and skill in the profession can think of accepting it; that of the latter is so mean that no one of the least generosity, sentiment or pretensions to merit can consent to act for it. In a word these are inconveniences of an interesting nature; they amount to an exclusion of those persons who could perform the duties of those offices, and if not redressed, there is not the smallest probability that any can be prevailed upon to enter them again." Whatever criticism we may make upon Gen. Washington's English, we cannot say that his meaning is ever obscure.

That Washington took a continued interest in the personnel and morale of his surgeons is shown by a letter to Hancock where he writes, "No less attention should be paid to the choice of surgeons than of other officers of the army. They should undergo a regular examination, and if not appointed by the Director-General and surgeons of the hospital, they ought to be subordinate to and governed by his directions. The regimental surgeons I am speaking of, many of whom are very great rascals, countenancing the men in sham complaints to exempt them from duty, and often receiving bribes to certify indispositions with a view to procure discharges or furloughs. In short there is a continual bickering among them, which tends greatly to the injury of the sick, and will always subsist until the regimental surgeons are made to look up to the Director-General of the hospital as a superior. . . . . The regimental surgeons are aiming, I am persuaded, to break up the general hospitals, and have in numberless instances drawn for medicines, stores, etc., in the most profuse and extravagant manner for private purposes."

That the regimental surgeons were not the only ones who received hard words, and that officers were not of one mind in this matter, the following letter of Gen. Smallwood of Maryland to the Council of Safety of his state will show. He says, "The Directors of the general hospitals who supply and provide for the sick, are extremely remiss and inattentive to the well-being and comfort of these unhappy men; out of this train they cannot be taken. I have withdrawn all mine long ago and placed in comfortable houses in the country and supplied with only the common rations. Even this is preferable to the fare of a general hospital. . . . . One good-seasoned and well-trained soldier recovered to health is worth a dozen new recruits, and is often easier recovered than to get a new recruit, exclusive of which, this neglect is very discouraging to the soldiery, and must injure the service on new enlistments after the troops go into winter quarters." That the devotees of Mars have always offered oblations to Venus even in the hardest times, the following resolution passed by a committee of Congress in 1778 while the army was stationed at Valley Forge will show: "*Resolved*, That the sum of ten dollars shall be paid by every officer and the sum of four dollars by every soldier, who shall enter or be sent to any hospital to be cured of a venereal disease, which sum shall be deducted out of their pay. . . . . The money so arising to be paid to the Director-General or his order, to be appropriated to the purchasing of blankets and shirts for the use of sick soldiers in the hospital." There is no evidence that there was any result from this resolution one way or the other, either in diminishing the number of such cases, or in producing a considerable revenue in consequence of this drastic measure.

Thacher gives us the following picture of an American hospital during the Revolution. This one was at Albany, and the

time just after Burgoyne's surrender. "This hospital is now crowded with officers and soldiers from the field of battle; those belonging to the British and Hessian troops are accommodated in the same hospital with our own men, and receive equal care and attention. The foreigners are under the care and management of their own surgeons. I have been present at some of their capital operations, and remarked that the English surgeons perform with skill and dexterity; but the Germans, with a few exceptions, do no credit to their profession. Some of them are the most uncouth and clumsy operators I ever witnessed, and appear to be destitute of all sympathy and tenderness towards the suffering patient. Not less than one thousand wounded and sick are now in this city. The Dutch church and several private houses are occupied as hospitals. We have about thirty surgeons and mates, and all are constantly employed."

Exactly what the methods were of operating, and dressing wounds during this war I have not been able to determine. I have not found any accurate and full account of this matter, and do not believe that careful records of operations and of wounds were kept by any one. It is safe to conclude that their methods were at least as good as those of any army of that day, considering the means at their disposal. Apart from anæsthesia, fewer advances had been made in military surgery from the time of the American Revolution to our own war between the states, beginning in 1861, than in other branches of medicine. In neither war were gauze dressings used, nor was there any idea of aseptic or antiseptic surgery. In both wars, much suppuration was taken as a matter of course. In both it is fair to believe that septicæmia and suppurative fever abounded. Certainly in our late Civil War hospital-gangrene occurred, and maggots infesting wounds were seen not infrequently. From the fact that round bullets were exclusively used in the Revolutionary War, it is certain that gunshot wounds were of a somewhat different character from most of those in our Civil War, and it is probable that sabre and bayonet wounds were relatively more common than in our Civil War. In both wars it was observed that wounded soldiers did much the best who were gotten into hospital tents, and out of houses, and that buildings with high roofs were far better for the patients than the best of ordinary houses. It is safe to believe that tetanus was about as frequent in one as in the other.

Here are the names of some of the physicians, surgeon-generals and deputies of the different departments from 1776 to 1783 in the Army of the American Revolution:

John Morgan (Pa.).	Philip Turner (Conn.).
John Warren (Mass.).	Jas. Tilton (Del.).
Isaac Foster (Mass.).	Malachi Treat (N. Y.).
Benj. Rush (Pa.).	Moses Bloomfield (N. J.)
John Cochran (Pa.).	Thomas Bond (Pa.).
Jas. Craik (Md.).	James Brown (Md.).
William Eustis (Mass.).	Wm. Brown (Md.).
Dr. Wm. Shippen (Pa.).	Jonathan Potts (Pa.).
Walter Jones (Va.).	Dr. Forgue (Conn.).
Samuel Stringer (Md.).	Dr. Charles McKnight (N. J.).
Wm. Rickman (Va.).	Dr. Wm. Burnett (N. J.).

Ammi R. Cutter (N. H.).

There were twenty-three who were either surgeon-generals or deputies. There were altogether twelve hundred men in the surgical service of the army. A large number of these had already had some experience in military surgery during the French and Indian War, while nearly all of the men at the heads of departments had had exceptional opportunities in European hospitals, and schools of medicine.

I will give some details concerning a few of the most prominent men.

Dr. William Shippen, Jr., born in 1736 and died 1808, at the age of 72 years. He graduated at Princeton in 1754 and at Edinburgh in 1761; had previously studied medicine with his father and later with the two Hunters, Wm. Hewson, Sir John Pringle, Cullen and the elder Munroe. He taught anatomy at the College of Philadelphia Medical School and was made chief physician for the Flying Camp in July, 1776. On April 11, 1777, he was made director-general of all the hospitals in the army. In 1798, his only son died, after which he seemed to lose all interest in his profession and in his medical school, and resigned his commission in June, 1781. Another account says that in 1776 he was made medical director at Trenton, and that later he had entire supervision of all camps on the west bank of the Hudson River.

Samuel Stringer was a native of Maryland. He studied medicine with Dr. Bond of Philadelphia, and served as surgeon throughout the French and Indian War in the British Army. He was made director-general of hospitals August 20, 1776. Was discharged January 9, 1777, and died at the age of 83 years.

John Morgan, M. D., F. R. S., was born in Philadelphia in 1735. He was educated in Maryland, graduated in Philadelphia in 1754, and studied medicine with a Dr. Redman in that city. He served as surgeon in the French and Indian War. In 1760 he went to France, and later attended lectures and dissections by Wm. Hunter, graduating at Edinburgh in 1763. He studied under both the Munroes, Cullen, Rutherford, Hope and others. He knew Voltaire and Morgagni. He was made an F. R. S. in London, and was appointed professor of theory and practice in the Medical College of Philadelphia. He died in 1789 at the age of only 54 years. The cause of his death was grief and disappointment at the injustice done him by his dismissal from the army. A sketch of his work has already been given.

Dr. William Rickman was made physician and director-general of hospitals in Virginia, later director-general of hospitals in the Southern Department. He was charged with neglecting to care for his patients from Virginia and North Carolina at Alexandria, but the charges were dismissed.

Benjamin Rush, perhaps the most prominent of all our early American physicians, was born in 1745, and was graduated at Princeton, in 1760. He took his M. D. in Edinburgh in 1768, practised in the London and Paris hospitals, and returning to America, was made professor of chemistry in the Medical school in Philadelphia. From the first he was a great patriot and represented Pennsylvania in Congress (Colonial) in 1776. He is well known as one of the signers of the Declara-

tion of Independence. He was widely known, not only as a physician but as a public-spirited man and a citizen. He was not fond of surgery, but accepted the position of physician-general to the army. He received but little lustre from his military career, and was constantly complaining to Congress about his superiors. It is said that Gen. Washington thought he had written anonymous letters and he was suspected of a connection with the wretched Conway cabal (1777). However this may be, Washington made him director of the Mint, and he held this position for fourteen years. (See American Revolution, by Fiske.) He was one of the founders of Dickinson College. In 1811 the Emperor of Russia sent him a gold ring as a testimonial of appreciation of his professional ability. He died April 14, 1813, at the age of 68 years.

Philip Turner was born in Norwich, Conn., in 1740, and was one of the few of the prominent men of his group whose studies were carried on in this country exclusively. He served in the French and Indian War as assistant surgeon to a Provincial regiment at Ticonderoga. Returning in 1783 to Norwich, he married his preceptor's daughter. He soon gained a reputation as a skillful operative surgeon. He was the first surgeon of Connecticut troops at the siege of Boston, and is said to have been the most skillful operator in the Army of the Revolution. Dr. Shippen remarked that he had never seen any one who excelled him as an operator, in Europe or America. He was successful in 18 out of 20 lithotomies, a large percent in those days, and a good one in any generation. His fame, rather than any influence, gained him the position of director-general in the reorganization of the medical department of the army. From motives of policy it was deemed best to reconsider the vote, and Dr. Shippen was then given the position.

William Burnett graduated in 1745 at the College of New Jersey, then located at Newark. He seems to have been a gentleman of culture.

Dr. Walter Jones of Northampton County, Virginia, appears to have been a man of parts. He graduated at Edinburgh in 1769-1770, and was made physician-general of the army. He found the office little to his taste, for he resigned after holding the position two months and returned to his private practice. He was a graduate of St. Mary's College, Virginia, in 1760.

Charles McKnight was a native of New Jersey, born October 10, 1750. He was graduated at Princeton, in 1771, pursued his studies with Dr. Shippen, and was appointed senior surgeon of the Flying Hospital of the Middle Department. At the end of the war he went to New York City to reside, where he had the distinction of being one of the first physicians in New York to use a carriage. He was professor of anatomy in Columbia College, and published a successful result of an operation for extra-uterine pregnancy.

Ammi Cutter was a native of Maine, born 1730, and died 1819, aged 89 years. He was graduated from Harvard College in 1752, and served during the French and Indian War in 1758. He was also given the honorary degree of M. D. by Harvard College.

Dr. William Brown, of Maryland, was the successor of Benj. Rush. He graduated at Edinburgh, in 1768. His private practice and home were in Alexandria, Va. The physicians of Maryland in Revolutionary days, like some of their successors of to-day, were fond of politics. In the former days they were generally looked to for advice in the Councils of Safety, and among these we find the names of Dr. John Archer of Harford County, of Ephraim Howard of Anne Arundel County and of Richard Brooks of Prince George County.

In the list of these men, there are one or two more points of especial interest. At the time of his death Dr. Rush was 68 years of age. Dr. Shippen 72 years of age. Dr. Cutter 89 years of age. Dr. Turner, 75 years of age. Dr. Stringer, 83 years of age. Dr. Morgan, 58 years of age.

Concerning their early education, Drs. Shippen, Rush, Jones, McKnight, Cutter and Morgan had both academic and medical degrees. Dr. Burnett had only an academic degree and Dr. Turner, one of the best of them all, had neither.

It is clear that with the experience they had gained in the French and Indian War these men were most valuable to direct the medical department of the army, and also it is obvious that an army, which was short of clothing and shoes at times, could not be expected to have at all times an abundance of medical supplies. Our greatest regret is that more complete records and details of their work have not been left behind, for plenty of work was done and most of it under great disadvantages.

PROCEEDINGS OF SOCIETIES.

THE JOHNS HOPKINS HOSPITAL MEDICAL SOCIETY.

JANUARY 4, 1915.

Exhibition of Case. DR. F. A. EVANS.

This patient, Dr. A., has been practising medicine in Fayoum, Egypt, for the last 15 years. He entered the hospital on Dec. 23, 1914, complaining of cysticercus cellulosa cerebralis. His family and personal history has no relation to his present illness. The present illness began in March, 1912, when he first noticed segments of tapeworm in his stools. He was able to recover the worm, but could not find the head. In May, 1913, 13 months later, he again noticed segments, but was unable to find the head. He had a severe convulsion at this time, with no premonitory symptoms except an intense nausea for about 30 seconds before the onset. He says he was unconscious for 30 minutes. The attack was followed by severe subconjunctival hæmorrhage and injection of the eyeball. Two months later, July 1913, 15 months after he had found the first segments in his stools, he noticed what he diagnosed as cysticerci in the subcutaneous tissue. These were most abundant in the temporal and masseter regions and on the forearms. For a period of six months they occurred in successive groups. In Nov., 1913, one was removed with the result that the patient's diagnosis was confirmed by Drs. Toors and Ferguson of Kasi el Ainy and his case presented before the Cairo Medical Society. In the previous July he had gone to Austria and during the voyage was very seasick. Dr. A. himself suggests the hypothesis that during the attack he had regurgitated some of the segments and infected himself. In Jan., 1914.

he had a second severe convulsion, similar to the first. From that time until May, 1914, he was practically free. Between May and Nov. 5, he had the third, fourth, fifth and sixth convulsions. The third and fourth occurred without premonitory symptoms. The fifth and sixth were only 12 days apart and each was preceded by a twitching of the right arm. For four or five days preceding the fifth general convulsion he had noticed difficulty in writing and a tendency to drop the second and fourth letters in his signature. Before the sixth there was simply the premonitory twitching of the right arm. On Nov. 28 and continuing until Dec. 16, he had a series of what he describes as epileptiform seizures of the left arm, lasting for five or ten minutes and quite severe. On one or two occasions the left foot was involved and once he almost fell. For the last year and a half he has been troubled with numerous headaches of sudden onset and as sudden disappearance, associated with visual error and inability to pick up the next line in reading. At no time have ova been found in his stools, and the stools of his family and servants have also been examined with negative results. He has eaten very little pork, and never, so far as he is aware, except when it was well cooked. The parasite, however, was the tænia solium.

Physical examination showed a sparely nourished, afebrile man, slightly pale. The uvula was retracted slightly to the right on phonation. The thyroid isthmus could be palpated, but no eye signs and no visual disturbances were noted. In fact there was no evidence of involvement of any cranial nerves. In the posterior cervical region, there was a small nodule about the size of a pea, but Dr. A. does not believe that this is a cyst. There was some arteriosclerosis and a slightly enlarged liver. R. b. c. 4,967,000; w. b. c. 6,960; hæmoglobin 94 per cent. The differential count showed 35 per cent neutrophiles, 3 per cent eosinophiles, 1 basophile only in 300 cells, 45 per cent small mononuclears, 11 per cent large mononuclears and 2 per cent transitionals. There was no abnormality of the red blood cells. Repeated examinations of the stools were negative for parasitic ova. The Wassermann was negative. The eye-grounds were normal. Repeated examinations of the urine revealed no pathological condition; there was no sugar. On X-ray examination of the head, Dr. Waters described a small shadow in the pineal region, showing three small dense areas and tapering off in the direction of the sella, suggesting a tad-pole appearance. Calcification of the pineal gland and of the choroid must be considered, but the shadow is not typical of these conditions, and Dr. Waters, taking his findings in conjunction with the history, favors the diagnosis of cysticercus cerebralis.

Anti-typhoid Vaccination. MAJOR E. R. WHITMORE, U. S. A.

Major Whitmore described the vaccine used by the United States Army and the technique employed in its preparation. The vaccine is derived from a single strain of low virulence obtained from a patient at Netley, England, in 1900.

In discussing the length of time that the vaccine retains its immunizing qualities, Major Whitmore spoke of the results obtained by Leishman, who sent a supply of vaccine to India which was not kept in a refrigerator. It was tested after six months and found to be still good. The United States Army, however, insists upon a time limit of four months.

The administration calls for subcutaneous injection, which is followed by a local and sometimes by a general reaction. Russell kept a record of over 130,000 injections and found that in over 96 per cent the general reaction was mild or absent.

Vaccine treatment was inaugurated in the army in 1909, and in 1911 vaccination was made compulsory for all persons mobilized in the camp in Texas. There were 13,000 men in camp for a perior of four months, with only two deaths from typhoid, a decided contrast to conditions in the camp of 11,000 men in Jacksonville during the Spanish-American War, where, with similar surroundings, there were 2693 certain or probable cases of typhoid, with 214 deaths from the disease. There have been no cases of typhoid in an army camp since 1911. In September, 1911, vaccination was made compulsory for all persons under 45 years of age. During the past year there were six cases of typhoid in the whole army, two in unvaccinated men and four in vaccinated men. Of these latter, three had received one dose and one had received a second dose of the vaccine just before entering the hospital. It is evident, therefore, that all four patients had been infected before receiving the vaccine.

The duration of the immunity seems to be uncertain. In some patients agglutination disappeared from the blood within two years. In the army, the dosage for a second administration of the vaccine is the same as that given the first time.

In regard to the question of the negative phase—as to whether vaccination increases susceptibility for a time—statistics compiled by various observers fail to show any proof in favor of this theory, especially when the present mode of vaccination is employed.

With regard to the contention that tuberculosis is caused by the vaccine, statistics show that tuberculosis is actually decreasing in the army and also in the navy, where vaccination is also compulsory.

Vaccination for typhoid is of course now quite common, but one is not ready yet to advise it for the general community. To persons, however, who intend to move into a locality where typhoid fever is prevalent and to travelers, who cannot be sure what they are eating or drinking, this prophylactic measure would seem to be a wise precaution.

Diphtheria Bacillus Carriers. DR. C. G. GUTHRIE.

This communication referred to work carried on by Dr. Guthrie, Dr. Moss and others, which will be reported in detail later. The incidence of the diphtheria bacillus carriers was determined by the study of over 6,000 throat cultures. Continued study showed a striking discrepancy between the number of carriers and the instances of clinical diphtheria. Whenever positive cultures were encountered, the diphtheria organisms were isolated and the original findings confirmed by careful study. It was found that from 80 to 90 per cent of the carriers harbored organisms which were avirulent. These organisms were typical both morphologically and culturally, and differed from the virulent organisms only in their inability to produce toxin. The validity of the guinea-pig test for virulence was confirmed by throat inoculations in human volunteers. The avirulent organisms caused no lesions, whereas the ones, that had previously been determined to be virulent by guinea-pig inoculation produced clinical diphtheria. As a result of the human inoculations, some of the volunteers became carriers and were carefully followed for months, or until they became free from diphtheria bacilli. Isolations were made from their throats at frequent intervals and it was found that the organisms retained their original characteristics—that is, the virulent organisms remained virulent, while those originally avirulent continued so after many months' sojourn in the human throat. As a result of this study, it is believed that carriers of avirulent diphtheria bacilli constitute no menace to the public health.

JANUARY 18, 1915.

1. *** Studies on the Relation Between Diet and Pellagra.** DR. CARL VOEGTLIN.

2. *** A Brief Review of Some Phases of the Work of the Robert M. Thompson Pellagra Commission.** DR. J. V. SILER.

* These papers, together with the discussions, will appear later in the BULLETIN.

THE JOHNS HOPKINS HOSPITAL HISTORICAL CLUB.

JANUARY 11, 1915.

1. * **Mithridatium and Theriac. The Most Famous Remedies of Old Medicine.** DR. GEORGE W. CORNER.
2. * **Dr. John W. Francis: Medical Editor and Writer.** DR. C. W. G. ROHRER.

THE LAENNEC.

JANUARY 25, 1915.

1. * **The Relation Between Clinical and Laboratory Data in Tuberculosis.** DR. A. H. CAULFIELD.
2. * **Some Cultural Studies on the Tubercle Bacillus.** MR. S. A. PETROFF.

NOTES ON NEW BOOKS.

A Treatise on Clinical Medicine. By WILLIAM HANNA THOMSON, M. D., LL. D. Cloth, $5. (*Philadelphia and London: W. B. Saunders Company, 1914.*)

In his preface the author states that a treatise on clinical medicine should chiefly consider those subjects which concern the physician in dealing with the living patient. As a suitable introduction to such a treatise he devotes a section of some 60 pages to a discussion of common symptoms, the proper interpretation of which are of vital importance. These symptoms are "catching cold," pain, emaciation, cough, dyspnea, edema and vomiting. The treatment of some of these is good, of most, valueless. He divides remedies into non-medicinal and medicinal, including in the first group "electricity, cold, heat and change"; medicines being of two kinds, functional and constitutional. This latter classification is hardly in accord with modern pharmacological views.

Part 2 is devoted to the infections, which are classified according to their usual mode of communication. Here there are some rather glaring inconsistencies. Typhoid fever is not included in the group of acute infections which are directly contagious, while under chronic infections, which are directly contagious, are included tabes, paresis and gonorrhea. Acute poliomyelitis is not included under infections at all and the sporadic form is "due to cold affecting some branches of the interior spinal area."

The main portion of the book is taken up with the diseases of the special tissues and organs. The chapter on diseases of the blood is an excellent example of the method employed. Thus, pernicious anemia is treated in less than two pages and is characterized by "specific red cell changes, especially by their increased size so that they are called megaloblasts." No mention is made of what happens to the leucocytes. Four lines suffice to cover the treatment of leukemia and benzol is not mentioned. Paroxysmal hemoglobinuria is treated "by the use of warm instead of cold water." One page covers all the diseases of the spleen. No mention is made of the value of the modern tests for renal function and believing that most of the conditions of chronic nephritis are due to infections by B. coli, the author recommends careful treatment of the intestinal digestion: he also gives ten-drop doses four times a day, continuously, of tincture of aconite and 1/24 gr. of corrosive sublimate three times a day. Indicanuria is said to be a morbid condition of the urine which should be treated with urotropin. Bence-Jones' proteinuria receives no notice.

The treatment of diabetes "must be wholly empirical." Codein, cod liver oil, iron and Pluto water are recommended in obvious preference to an intelligent study of the patient's dietetic possibilities. Similarly, since "clinical facts furnish much more trustworthy information than any chemical theories about the nature of gout," the author utterly disregards the value of dietetic treatment and relies upon colchicum and Laville's extract. Exclusive of goiter and exophthalmos, the author cites no less than 27 other "distinctly characteristic symptoms of Graves' disease," included in which are vertigo, itching, vesical irritability and sudden death from syncope. The lead line due to "sulphite of lead should always be looked after, as it may be removed by a daily use of the tooth brush." Migraine is regarded as essentially a digestive disorder. Albuminuric retinitis is included under disorders of the cranial nerves. Similar glaring inaccuracies could be quoted almost *ad infinitum*. Mention of the Wassermann reaction is nowhere to be found.

The book is not illustrated and is poorly indexed.

The Ileo-Cæcal Valve. By A. H. RUTHERFORD, M. D. (Edin.). 70 pp., with 2 colored and 20 black and white plates. $2.25. (*New York: Paul B. Hoeber.*)

Neither the importance of the subject nor its treatment justifies the presentation of this thesis in book form. Almost one-third of the book is consumed in individual protocols of numerous specimens. The photographs are as redundant as the text, and add but little to its elucidation. The amount of original research represented is scanty, and the summary adds nothing to our present conceptions of the anatomy and physiology of the ileocæcal valve.

The Pharmacy Handbook. By F. W. CROSSLEY-HOLLAND, F. C. S., Pharmacist, Member of the Pharmaceutical Society of Great Britain, etc. (*London: Henry Frowde and Hodder & Stoughton, 1914.*)

The title is misleading, inasmuch as the book does not deal with the pharmaceutical art, neither does it include subject matter that is found in the various treatises on pharmacy. However, as a book of reference, it contains valuable information gleaned from various sources and conveniently arranged. The treatment of such subjects as serums, colloids, anæsthetics and pharmaceutical bacteriology are thoroughly up to date and should be found very helpful to the pharmacist and physician.

A Text-Book of Medical Diagnosis. By JAMES M. ANDERS and L. NAPOLEON BOSTON. 1248 pp. (*W. P. Saunders Co., 1914.*)

This volume is the second edition to appear within three years, and according to the statement of the editors the process of revision of the first edition has been going on for the past two years.

The aims of the book have been first, to furnish an improved method of determining the clinical features of disease, and second, to emphasize the importance of correlating symptoms with the structural changes which cause them.

After a short introduction which covers general and special considerations in the investigation, history-taking and physical examination of the patient, the diseases of the various systems of the body are taken up. These include disorders of the respiratory systems, circulatory, digestive, urinary systems, acute infectious diseases, animal parasitic diseases and constitutional diseases. A special section is devoted to diseases of the nervous system. The various subheadings under these systems are treated according to the following scheme: pathological definition of the condition, the exciting and predisposing factors, the physical complaint and symptoms, the physical signs, laboratory diagnosis, summary of the diagnostic features, and finally differential diagnosis of the condition. No treatment is given. Throughout the book there are a number of differential tables which should prove quite helpful.

It is rather curious that this second edition, which contains a discussion of the electro-cardiogram, the cobra venom reaction in syphilis and other newer diagnostic aids, should make no mention of the modern and widely accepted tests for renal function; nor is there any discussion given of the examination of the cerebro-spinal fluid.

Among the features to be criticized, a few will be mentioned. Under parasitic diseases of the skin, no reference is made to infections with pediculi. The recent studies on the significance of the Bence-Jones body have been overlooked, and the test given for its detection is of no value. The reagent advised for use in the Esbach method of quantitative albumin estimations has long since been discarded in favor of the more satisfactory Tsuchiya's reagent. Under typhoid fever the statement is made that the Widal reaction is usually obtained at the end of the first week and it is given obvious preference as a diagnostic measure over blood cultures. It is hard to understand just why Addison's disease is included under abnormal conditions of the urinary system. Similarly, it seems rather inconsistent to classify exophthalmic goiter, acromegaly, arthritis deformans and Paget's disease under diseases of the central nervous system.

A great many illustrations are scattered through the text, the majority of which are perhaps useful. The colored plates are fair.

It is a grave question in the mind of the reviewer whether such books are really to be commended. The endeavor to incorporate within one volume so much information, about so many different conditions, must of necessity lead to a brevity of description that tends to the development of a similar short-sightedness on the part of the person using the book. It leaves entirely too much to the imagination, in many instances, to make the book of true value to the beginner. To the seasoned practitioner the volume doubtless will prove of considerable aid as a quick and ready reference. But it is possible that even here it will not fully satisfy the mind which is genuinely intent upon learning once and for all the essential clinical and laboratory features which make for sure and intelligent diagnosis. S. R. M.

Diseases of the Heart. By JOHN COWAN, D. Sc., M. D., F. R. F. P. S. (*Philadelphia: Lea & Febiger, 1914.*)

New books, like new acquaintances, are bound to give the reader a new viewpoint, and will question the validity of his own conceptions. Especially is this true if the author has had the extensive experience of John Cowan—the descendant of the long line of well-known Scottish physicians. His recently edited book of 450 pages sums up his clinical opinions, and, with the assistance of very short chapters by Arthur Ballantyne on the ocular manifestations in arteriosclerosis, and by W. T. Ritchie on the electrocardiogram, endeavors "to review the whole subject (of cardiac knowledge) in the light of recent advances."

The whole could well be divided into four parts, of which physiology, pathology, physical signs and symptoms, and treatment, are section headlines. The author illustrates abundantly with tracings and case histories, obtained, for the most part, in his own clinic. His conclusions may sometimes be questioned, especially as in his interpretation of polygraph curves he writes, in discussing the apex cardiogram: "with relaxation of the ventricle, the curve rapidly falls, and as soon as the pressure within the auricle exceeds the pressure within the ventricle, the auricular-ventricular valves open—a time which coincides fairly accurately with the lowest point upon the tracing. Succeeding the fall there is often a well-marked wave—an instrumental fault due to the momentum of the recording lever and best marked in cases where the fall is most abrupt." This interpretation of rather fundamental points—the protodiastolic wave and the opening of the auricular-ventricular valves—is certainly not generally acceptable, and would seem to have been proved wrong by the work of Henderson, Thayer, and others.

The discussion of the types of coupled rhythm is interesting and suggestive. His deductions, based as they generally are on polygraphic tracing without the electro-cardiographic findings, are debatable in many instances, and especially in regard to his diagnosis of nodal extra-systoles. In view of his effort to portray the recent advances, it is surprising that only a small paragraph in the section of the pathology of acute endocarditis is granted the streptococcus viridans and its manifestations.

The book, while in no way the reference book of Hirschfelder or Lewis, nor a book to be put in the hands of untrained medical students, is very valuable, and can be profitably studied by the medical profession. In reading it the general practitioner can hardly fail to appreciate the importance of the use of polygraphs for the exact study of his cardiac cases.

A Reference Handbook of the Medical Sciences. Vol. IV. By various writers. Third edition edited by THOMAS LATHROP STEDMAN, A. M., M. D., EMB-HAY. Cloth, $7. (*New York: William Wood & Co., 1914.*)

This volume, like its predecessors, is attractively bound, well printed, and contains a large number of excellent illustrations. The articles are wide enough in scope to cover the needs of the general practitioner. The subjects of diseases of the foot, fractures, gunshot wounds, etc., have been handled in such a way as to furnish very definite and helpful guides both to diagnosis and treatment. The article on "Foods for the Sick" takes due recognition of protein, fat and carbohydrate contents, as well as of the caloric value of food materials, and shows how such figures may easily be applied to very great advantage by the practitioner.

An interesting article, which is supplemented by good illustrations, sets forth the possibilities of esophagoscopy and gastroscopy. Subjects related to medicine and of more than passing interest to the physician, such as evolution, medical ethics, climatology, are given considerable space. The biographical sketches are too brief and too dry to be any more inspiring than the bald statements to be found in any medical directory.

These volumes should be especially useful to men living far from medical libraries, for they are very complete in range of subjects and provide much information. It is to be regretted that in most of the contributions the references to original sources have either been entirely neglected or have suffered a very meager compilation.

Clinical Hematology: An Introduction to the Clinical Study of the So-Called Blood Diseases and of Allied Disorders. By GORDON R. WARD, M. D., Fellow of the Royal Society of Medicine, Medical Society of London, etc. Octavo of 394 pages, illustrated. Cloth, $3.50, net. (*Philadelphia and London: W. B. Saunders Company, 1914.*)

This volume, according to the author, is primarily concerned with the clinical study of the so-called blood diseases, which has been overshadowed by exclusively pathological investigations; and secondly, it is concerned with a classification of the blood diseases necessary to an understanding of their nature. And yet the author has apparently overlooked the fact that the nature of the blood diseases cannot be clearly comprehended unless the fundamental pathological features are understood. The classification offered in the opening chapter is open to serious criticism, a fact which he recognizes but justifies on the basis that a bad one is better than none. In the first place, it is inaccurate and hence misleading. In the second place, it includes conditions which are not essentially blood diseases at all; and finally, well-known disorders, having a recognized pathological basis, are wrongly grouped. For example, hemochromatosis is considered

under the heading of a primary disorder, a red cell destruction, whereas the disease is regarded by most authorities as a primary disorder of metabolism in which, according to the work of Sprunt, there is no evidence of an abnormal breaking down of red cells. The newer work on Hodgkin's Disease, by Bunting, is not mentioned, the affection being classed as one primarily of the blood forming organs. Chlorosis and hemophilia are considered as primary diseases of the blood plasma, and pernicious anemia is said to be a disease characterized by increased red cell destruction and due "to a specific organism not yet isolated, its usual site of invasion being the alimentary tract." On the other hand, it would appear that the author does not consider pernicious anemia as a blood entity, for on page 360 he makes the statement that "the blood picture may be that of an Addisonian anemia or almost every variety of anemia that we can think of."

No parasitic diseases of the blood are considered. The section on the methods of blood examination is not complete, for the value of fresh blood studies is scarcely touched upon, nor can we agree with the statement that transitional cells are younger forms of neutrophilic leucocytes, or that any cell which is not a lymphocyte and has not a lobed nucleus is a large mononuclear.

Without wishing to be over-critical, it seems to the reviewer that the book abounds in misstatements which, though they may genuinely reflect the author's own views, are not in accord with those most generally accepted. The pictures, with the exception of two colored plates, are only fair, while those of the blood cells on page 35 are very poor. Briefly, the author seems to be content with merely driving home clinical features without due regard for the pathological foundation of the diseases in question, from which alone we may ultimately hope for a satisfactory classification. It is to be hoped that a revision of the work will correct this evident lack of balance. S. R. M.

Military Hygiene and Sanitation. By FRANK R. KEEFER, A. M., M. D. Cloth, $1.50. (*Philadelphia and London: W. B. Saunders Company, 1914.*)

A text-book on military hygiene is peculiarly interesting at the present time, when the care of soldiers is occupying the attention of the civil and military authorities the world over, and this little publication from the pen of the Professor of Military Hygiene in the U. S. Military Academy at West Point, comes at an opportune moment. Its three hundred pages of fifteen chapters are devoted to the most important branches of this science, such as physical training, preventable diseases, clothing, water supply, etc. One chapter takes up especially the subject of venereal disease and another alcohol and other narcotics. The close association between drunkenness and venereal disease is well brought out and various remedies are suggested for the curtailment of the two evils. The book is systematically arranged, carefully written, and gives an excellent résumé of the important doctrines in military hygiene.

BOOKS RECEIVED.

The Clinics of John B. Murphy, M. D., at Mercy Hospital, Chicago. Vol. III, No. 4. August, 1914. 8°. W. B. Saunders Company, Philadelphia and London.

Manual of Obstetrics. By Edward P. Davis, A. M., M. D. With 171 illustrations. 1914. 12°. 463 pages. W. B. Saunders Company, Philadelphia and London.

Chemistry for Nurses. By Reuben Ottenberg, A. M., M. D. 1914. 12°. 141 pages. Macmillan Company, New York.

Practical Bandaging; Including Adhesive and Plaster-of-Paris Dressings. By Eldridge L. Eliason, A. B., M. D. 155 original drawings and photographs. 1914. 8°. 124 pages. J. B. Lippincott Company, Philadelphia and London.

Baltimore, Department of Health. Department of Public Safety. Annual Report. Sub-Department of Health. To the Mayor and City Council of Baltimore for the Fiscal Year ended December 31, 1913. 1914. 8°. 782 pages. Baltimore.

Infection and Resistance. An Exposition of the Biological Phenomena Underlying the Occurrence of Infection and the Recovery of the Animal Body from Infectious Disease. By Hans Zinsser, M. D. With a chapter on Colloids and Colloidal Reactions by Professor Stewart W. Young. 1914. 8°. 546 pages. Macmillan Company, New York.

The Pharmacy Handbook. By F. W. Crossley-Holland, F. C. S. 1914. 12°. 224 pages. Henry Frowde and Hodder & Stoughton, London.

Medical Jurisprudence. A Statement of the Law of Forensic Medicine. By Elmer D. Brothers, B. S., LL. B. 1914. 8°. 301 pages. C. V. Mosby Company, St. Louis.

Pathogenic Microorganisms. By William Hallock Park, M. D., and Anna W. Williams, M. D. Fifth edition, enlarged and thoroughly revised. With 210 engravings and 9 full-page plates. 1914. 8°. 684 pages. Lea & Febiger, New York and Philadelphia.

The Tonsils, Faucial, Lingual, and Pharyngeal. With Some Account of the Posterior and Lateral Pharyngeal Nodules. By Harry A. Barnes, M. D. Illustrated. 1914. 8°. 168 pages. C. V. Mosby Company, St. Louis.

Contributions to the Science of Medicine and Physiology. By John C. Hemmeter, Phil. D., M. D., Sc. D., LL. D. Second series. Being a Collection of the Journal Publications of this Author from 1902 to 1914. Compiled by Thomas L. Patterson, M. A., and Charles C. Conser, M. D. 1914. 8°. Baltimore, Md.

Food Products. By Henry C. Sherman, Ph. D. 1914. 12°. 594 pages. Macmillan Company, New York.

Quain's Elements of Anatomy. Eleventh edition. Editors, Sir Edward Albert Schäfer, LL. D., Sc. D., M. D., F. R. S., Johnson Symington, M. D., F. R. S., and Thomas Hastie Bryce, M. A., M. D. In four volumes. Vol. II. Part II. *Splanchnology.* By J. Symington. With 349 illustrations. 1914. 8°. 392 pages. Longmans, Green & Co., London, New York, Bombay, Calcutta, and Madras.

Local and Regional Anesthesia. With chapters on Spinal, Epidural, Paravertebral, and Parasacral Analgesia, and on other Applications of Local and Regional Anesthesia to the Surgery of the Eye, Ear, Nose and Throat, and to Dental Practice. By Carroll W. Allen, M. D. With an Introduction by Rudolph Matas, M. D. Illustrated. 1914. 8°. 625 pages. W. B. Saunders Company, Philadelphia and London.

Abdominal Operations. By Sir Berkeley Moynihan, M. S. (London), F. R. C. S. In two volumes. Third edition, revised. Fully illustrated. 1914. 8°. Vol. I, 488 pages; Vol. II, 492 pages. W. B. Saunders Company, Philadelphia and London.

The Clinics of John B. Murphy, M. D., at Mercy Hospital, Chicago. Vol. III, No. 5. October, 1914. 8°. W. B. Saunders Company, Philadelphia and London.

American Gynecological Society. Transactions. Vol. XXXIX. For the year 1914. 1914. 8°. 520 pages. Philadelphia.

A Manual of Bacteriology, Clinical and Applied. By R. Tanner Hewlett, M. D., F. R. C. P., D. P. H. (Lond.). Fifth edition. 1914. 8°. 668 pages. C. V. Mosby Company, St. Louis.

Operative Surgery of the Nose, Throat, and Ear. By Hanau W. Loeb, A. M., M. D. In collaboration with Joseph C. Beck, M. D., R. Bishop Canfield, M. D., George W. Crile, M. D., Eugene A. Crockett, M. D., William H. Haskin, M. D., Robert Levy, M. D., Harris P. Mosher, M. D., George L. Richards, M. D., George E. Shambaugh, M. D., and George B. Wood, M. D. In two volumes. Vol. I. 409 illustrations. 1914. 8°. 390 pages. C. V. Mosby Company, St. Louis.

Essentials of Physiology. By F. A. Bainbridge, M. A., M. D. (Cantab.), D. Sc. (Lond.), F. R. C. P., and J. Acworth Menzies, M. D. (Edin.). With 134 illustrations. 1914. 8°. 434 pages. Longmans, Green & Co., London.

The Cancer Problem. By William Seaman Bainbridge, A. M., D. Sc., M. D. 1914. 8°. 534 pages. Macmillan Company, New York.

Urgent Surgery. By Félix Lejars. Translated from the seventh French edition by William S. Dickie, F. R. C. S. Third English impression. With 20 full-page plates and 1086 illustrations, of which 729 are drawn by Dr. E. Daleine and A. Leuba, and 198 are from original photographs. Vol. I: *Introductory, Head, Neck, Chest, Spine, Abdomen.* 1914. 8°. 614 pages. William Wood & Co., New York.

University of Michigan, Contributions from the Pathological Laboratory. Aldred Scott Warthin, Ph. D., M. D., Director. Reprints, Vol. VI, 1913-1914. 1914. 8°. Ann Arbor, Michigan.

Carnegie Endowment for International Peace. Founded December 14, 1910. Year Book for 1913-1914. 1914. 8°. 203 pages. Washington, D. C.

The Brain in Health and Disease. By Joseph Shaw Bolton, M. D., D. Sc. (Lond.), F. R. C. P. (Lond.). Longmans, Green & Co., New York; Edward Arnold, London.

Bellevue and Allied Hospitals. City of New York. Twelfth Annual Report. January 1, 1913, to December 31, 1913. 8°. 165 pages.

The Pocket Formulary for the Treatment of Disease in Children. By Ludwig Freyberger, J. P., M. D. (Vienna), M. R. C. P. (Lond.), M. R. C. S. (Eng.). Fourth revised and enlarged edition. Adapted to the British Pharmacopœia. With an appendix on Poisons, their Symptoms and Treatment. [1914.] 16°. 260 pages. Rebman Company, New York.

The Salvarsan Treatment of Syphilis in Private Practice. With Some Account of the Modern Methods of Diagnosis. By George Stopford-Taylor, M. D., M. R. C. S., and Robert William Mackenna, M. A., M. D., B. Ch. [1914.] 8°. 90 pages. Rebman Company, New York.

The Backward Baby. A Treatise on Idiocy and the Allied Mental Deficiencies in Infancy and Early Childhood. By Herman B. Sheffield, M. D. Awarded the Alvarenga Prize of the College of Physicians of Philadelphia, July 14, 1914. With 22 original illustrations in the text. [1915.] 8°. 184 pages. Rebman Company, New York.

The Diagnostics and Treatment of Tropical Diseases. By E. R. Stitt, A. B., Ph. G., M. D. With 86 illustrations. 1914. 12°. 421 pages. P. Blakiston's Son & Co., Philadelphia.

Morris's Human Anatomy. A Complete Systematic Treatise by English and American Authors. Edited by C. M. Jackson, M. S., M. D. 1182 illustrations, 358 printed in colors. Fifth edition, revised and largely rewritten. 1914. 4°. 1539 pages. P. Blakiston's Son & Co., Philadelphia.

Progressive Medicine. A Quarterly Digest of Advances, Discoveries and Improvements in the Medical and Surgical Sciences. Edited by Hobart Amory Hare, M. D., assisted by Leighton F. Appleman, M. D. Vol. IV. December, 1914. 8°. 413 pages. Lea & Febiger, Philadelphia and New York.

American Proctologic Society. Transactions of the Sixteenth Annual Meeting. Held at Hotel Chalfonte, Atlantic City, N. J., June 22 and 23, 1914. 8°. 157 pages. St. Louis, Mo.

NEW PUBLICATIONS.

The following six monographs:

Free Thrombi and Ball-Thrombi in the Heart. By J. H. Hewitt, M. D. 82 pages. Price, $1.00.

Benzol as a Leucotoxin. By Laurence Selling, M. D. 60 pages. Price, $1.00.

Primary Carcinoma of the Liver. By M. C. Winternitz, M. D. 42 pages. Price, 75 cents.

The Statistical Experience Data of the Johns Hopkins Hospital, Baltimore, Md., 1892-1911. By Frederick L. Hoffman, LL.D., F.S.S. 161 pages. Price, $2.00.

The Origin and Development of the Lymphatic System. By Florence R. Sabin. 94 pages. Price, $2.00.

The Nuclei Tuberis Laterales and the So-called Ganglion Opticum Basale. By Edward F. Malone, M. D. Price, $1.50.

are now on sale by The Johns Hopkins Press, Baltimore. Other monographs will appear from time to time.

The Johns Hopkins Hospital Bulletin are issued monthly. They are printed by the LORD BALTIMORE PRESS, Baltimore. Subscriptions, $2.00 a year (foreign postage, 50 cents), may be addressed to the publishers, THE JOHNS HOPKINS PRESS, BALTIMORE; single copies will be sent by mail for twenty-five cents each. Single copies may also be procured from the BALTIMORE NEWS CO., Baltimore.